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Influence Mechanism of Digital Transformation on the Growth Performance of Chinese Scientific and Technological Enterprises

TANG Yishan

Doctor of Management

Supervisors:
PhD Bráulio Alturas, Associate Professor,
ISCTE University Institute of Lisbon
PhD WANG Guofeng, Associate Professor,
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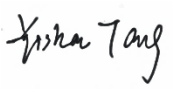
Signed:  Date: 2024.10.14

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Abstract

Digital transformation, as a crucial technological resource, is a key component of organizational knowledge in the digital economy. It has emerged as one of the most strategically significant resources for transforming industries and businesses in today's economy. It can steer the development of innovative, relevant, and valuable products, services, processes, and programs. Furthermore, it is seen as a strong precursor to enhancing corporate performance. Thus, examining the growth performance opportunities that digital transformation offers to Chinese high-tech enterprises is essential.

This study collects data from Chinese scientific and technological enterprises, rooted in the local Chinese context. It combines multiple theoretical perspectives of DCV and RBV theories to explore three main themes. First, it explores and reveals the positive impact of digital transformation on growth performance. Second, this study confirms the mediating mechanism of cross-border search between digital transformation and firm growth performance. Third, this study examines the boundary conditions between digital transformation and firm growth performance and reveals the moderating effects of managers' digital concern, organizational agility, and knowledge transfer dimensions (i.e., explicit and implicit knowledge transfer) in the theoretical model of this thesis.

This thesis utilizes regression analysis methods to test the integrated model to fill the research gap of digital transformation and firm growth performance. It contributes to the digital transformation application in the resource-based view, dynamic capability view, and growth performance-related theories. Additionally, it aims to provide specific digital transformation policies, guidelines, and initiatives for policymakers, governments, and stakeholders to support enterprise creativity and growth.

Keywords: Digital transformation, Chinese scientific and technological enterprises, Firm growth performance, Cross-border search capabilities, Dynamic capability view, Resource-based view

JEL: M1-Business Administration; M2-Business Economics

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Resumo

A transformação digital, como importante recurso tecnológico, é um elemento-chave do conhecimento organizacional na economia digital. Tornou-se um dos recursos estrategicamente mais significativos para a mudança nas indústrias e empresas na economia contemporânea. Pode orientar o desenvolvimento de novos produtos, serviços, processos e programas, que são considerados inovadores, apropriados e úteis. Além disso, é considerada forte antecedente ao crescimento do desempenho empresarial. Portanto, analisar as oportunidades de crescimento do desempenho, trazidas pela transformação digital, para empresas chinesas de alta tecnologia assume grande importância.

Este estudo recolhe dados de empresas científicas e tecnológicas chinesas, enraizadas no contexto chinês local, e combina múltiplas perspetivas teóricas, como a teoria DCV e a teoria RBV para explorar três temas principais. Em primeiro lugar, explora e revela o impacto positivo da transformação digital no desempenho do crescimento. Em segundo lugar, este estudo confirma o mecanismo mediador da fronteira entre transformação digital e crescimento do desempenho das empresas. Terceiro, este estudo examina as condições de fronteira entre transformação digital e crescimento do desempenho da empresa e revela os efeitos moderadores das dimensões preocupação digital dos gestores, agilidade organizacional e transferência de conhecimento (i.e., transferência de conhecimento explícita e implícita) no modelo teórico desta tese.

Esta tese usa métodos de análise regressiva para testar o modelo integrado para preencher a lacuna de pesquisa de transformação digital e crescimento do desempenho da empresa, e faz contribuições para a aplicação da transformação digital na visão baseada em recursos, visão de capacidade dinâmica e teoria relacionada ao desempenho de crescimento, e também ajuda a fornecer políticas específicas de transformação digital, diretrizes e iniciativas para formuladores de políticas, governos e *stakeholders* para apoiar atividades criativas de crescimento empresarial.

Palavras-chave: Transformação digital, Empresas científicas e tecnológicas chinesas, Crescimento do desempenho da empresa, Capacidades de pesquisa transfronteiriça, Visão de capacidade dinâmica, Visão baseada em recursos

JEL: M1-Administração de Empresas; M2 -Economia Empresarial

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摘要

数字化转型作为一种重要的技术资源，在数字经济中是组织知识的关键要素，它已成为在当代经济中改变行业和企业的最具战略意义的资源之一,可以引导新产品、服务、流程和程序的开发，这些新产品、服务、流程和程序的开发被认为是新颖、合适和有用的。而且，它被认为是影响企业绩效增长的一个强有力的前因。因此，剖析数字化转型给中国高新技术企业带来的成长绩效机遇具有重要意义。

本研究以中国科技型企业数据为研究样本，根植于中国本土情景，结合DCV理论和RBV理论等多个理论视角，主要探讨了三个主题。首先，探索并揭示了数字化转型对中国科技企业成长绩效的积极影响。其次，本研究证实了跨界搜索在中国科技企业数字化转型与企业成长绩效之间的中介作用机制。第三，本研究考察了数字化转型与企业成长绩效之间的边界条件，揭示了管理者数字化关注、组织敏捷性和知识传递维度（即显性和隐性知识传递）在本文理论模型中的调节作用。

本文通过采用回归分析的方法检验集成模型来填补数字化转型和企业成长绩效的相关研究空白，对数字化转型在资源基础观、动态能力观和成长绩效相关理论中的应用做出了贡献。同时，本文还有利于为政策制定者、政府和利益相关者提供具体的数字化转型政策、指导方针和倡议，以支持企业创造性活动和增长。

关键词：数字化转型，中国科技型企业，企业成长绩效，跨界搜索能力，动态能力观，资源基础观

JEL: M1-工商管理; M2-企业经济学

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List of Abbreviations

Abbreviations	Full Name
AI	Artificial Intelligence
ANNs	Artificial Neural Networks
ANOVA	Analysis of Variance
AVE	Average Variance Extracted
AWS	Amazon Web Services
CAST	Chinese Association for Science and Technology
CDO	Chief Digital Officers
CMV	Common Method Variance
CPC	Communist Party of China
CR	Composite Reliability
DApps	Decentralized Applications
DCV	Dynamic Capabilities View
EC2	Elastic Compute Cloud
EFA	Exploratory Factor Analysis
IaaS	Infrastructure-as-a-Service
IoT	Internet of Things
IT	Information Technology
NASA	National Aeronautics and Space Administration
NIS	National Institute of Standardization
PaaS	Platform-as-a-Service
RBV	Resource-Based View
RFID	Radio Frequency Identification
ROI	Return on Investment
ROS	Return on Sales
RQ	Research Question
S3	Simple Storage Service
SaaS	Software-as-a-Service

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Chapter 1: Introduction

This chapter looks at the background, problem statement, and objectives of the study. Again, it discusses research questions, methodology, and thesis outline and structure.

1.1 Background of the study

During the past few years, the rapidly changing global economy has created awareness among organizational leaders of the need to enhance their innovation and growth performance by engaging in digital transformation in creative activities since this is vital for increased productivity, global competitiveness, and sustainability (Eller et al., 2020; Khanchel, 2019). Understanding the impacts of IT on people's and organizations' lives and behavior can serve as an essential foundation for developing new technologies (Alturas, 2021). With the rapid popularization and application of the internet, big data, and artificial intelligence technologies, enterprises seeking growth, competitiveness, and survival need to strengthen their digital operation management. Thus, enterprises must develop digital capabilities to change organizational structures and identities (Westerman et al., 2014; Yoo et al., 2012) with constantly new digital innovation protocols (Bharadwaj et al., 2013; Eaton et al., 2015; Swanson & Ramiller, 2004; Tiwana et al., 2010), to enhance their performance outcomes.

Generally speaking, digital transformation refers to the transformation process in which enterprises utilize digital technologies such as big data, cloud computing, mobile, and social media to change their core business processes and create new revenue streams (Christian et al., 2016). Digital transformation can lead to the development of new products, services, processes, and procedures considered novel, suitable, and useful. The concept has become a buzzword in the business world in recent years. It has been identified as a potent antecedent to influence firm growth performance. Therefore, digital transformation has become a key factor for the rapid development of scientific and technological enterprises in advanced markets and few in emerging markets, and it is essential to promote the growth of all kinds of enterprises. Enterprises that integrate robust digitalization in their business designs have a chance for growth and survival in the global arena. Although there have been substantial empirical studies linking digital transformation with performance (Eller et al., 2020; Khanchel, 2019; Mubarak et al., 2019; Sundaram et al., 2020), some research information is still missing in the extant

literature, which needs attention.

Consequently, the study argued that a more in-depth and holistic examination of the phenomenon must be examined to broaden the understanding of digital transformation. Extant literature indicates little research on the mechanism of digital transformation in promoting the growth performance of Chinese scientific and technological enterprises. Therefore, the study's main purpose is to examine the relationship between digital transformation and firm growth performance of Chinese scientific and technological enterprises and simultaneously explore an in-depth impact mechanism of digital transformation on corporate growth performance.

1.2 Problem statement

Firms continuously search for effective ways to improve their competitiveness. In steady business environments, competitiveness has been realized via effective operational practices such as specialization of labor and cost control, as proposed in the early management and economics literature (Mourdoukoutas & Papadimitriou, 1998). However, current vicissitudes in the competitive environment, primarily the emergence of globalization (Birdthistle & Fleming, 2005; Burnes et al., 2003; Knight, 2000; Salavou et al., 2004), knowledge-based economies (Birdthistle & Fleming, 2005; Salavou et al., 2004), and advances in information technology (Vogelsang, 2010), have forced firms to continue to search new approach because conventional ways are no longer enough to offer a competitive advantage (Chirico & Salvato, 2008; Dixon, 1992).

Scholars have proposed the notion of digital transformation (Y. Y. K. Chen et al., 2016; Eller et al., 2020; Khanchel, 2019; Mubarak et al., 2019; Sundaram et al., 2020) as an effective way to improve firms' competitiveness and performance, particularly in today's turbulent environment (Libert et al., 2016; Ziyadin et al., 2019). For instance, Z. Ren et al. (2018) assert that increasing global competition creates challenges and opportunities for business organizations. For firms to survive in a competitive landscape, a transformation that alters conventional business methods is fundamental (Dehning et al., 2003). Thus, firms' ability to transform their traditional strategies of executing business tasks is keen to compete effectively in the business world. The concept of digital transformation is a "systematic strategy", "extremely multifaceted", and an "enterprise-wide endeavor" (Hess et al., 2016) to execute digital technologies innovatively "that can significantly shape an enterprise and its operational activities" (Matt et al., 2015).

Indeed, it allows enterprises to rethink customers' and environmental values to upsurge

their competitive edge (Berman et al., 2012), thereby enhancing organizational performance and growth (Hess et al., 2016; Singh & Hess, 2020). Academicians and practitioners have recognized digital transformation as a novel approach to gaining a competitive edge in intense and vibrant market environments. Many scholarships attest that digital transformation improves business performance, which, in turn, leads to a competitive edge (Y. Y. K. Chen et al., 2016; Eller et al., 2020; Khanchel, 2019; Mubarak et al., 2019; Sundaram et al., 2020).

However, despite the growing interest in digital transformation as an effective approach for organizational performance, growth, and productivity across the globe; the role of digital transformation in emerging economies firms' growth performance has not received adequate attention in the extant works. Therefore, it is crucial to analyze the opportunities, digital transformation presents to firms regarding growth performance in China's scientific and technological sectors. Notably, the mediating role of cross-border search capability and the moderating roles of managers' digital concern, organizational agility, and knowledge transfer dimensions (i.e., tacit and explicit knowledge transfer) in this context have been understudied in emerging economies. The researcher argues that these intermediary and moderating variables should not be excluded from a theoretical model that includes capability and growth links in emerging economies.

Emerging economies such as China offers better ground to probe this relationship. The Chinese economy is ranked first among all emerging economies (Boadu et al., 2018); over the past decades, it has received sufficient foreign direct investment from advanced and developing economies. Recent studies ranked the economy as the second-largest recipient of foreign direct investment behind the United States of America (Boadu et al., 2018). In addition, the country has created an enabling environment to facilitate business innovation performance, growth, and sustainability. Therefore, analyzing the growth performance opportunities brought by digital transformation to Chinese high-tech enterprises is of great significance.

To address these gaps, the current study argues that the dynamic capabilities view (DCV) and the resource-based view (RBV) offer a pertinent theoretical lens for scrutinizing the variables' probable associations. Explicitly, the study constructs a theoretical framework that elucidates that the combined influences of digital transformation, cross-border search capability, managers' digital concern, organizational agility, and knowledge transfer dimensions can be a determining variable on firms' growth performance.

First, the study follows DCV theory to examine the mediation mechanism of cross-border search capability, referred to a firm ability to pursue and obtain resources from an external environment to improve organizational functioning, which may also challenge and upset the

status quo of the organization and its power holders (Rosenkopf & Nerkar, 2001) in the digital transformation-firm growth performance relationship in the Chinese context. Earlier studies have proved that boundary-spanning has demonstrated significant differential effects on innovation and performance (Rosenkopf & Nerkar, 2001), and cross-border search capability has also been shown to relate to digital transformation. Consequently, it becomes evident that the relationship between digital transformation and firm growth performance can be mediated by cross-border search capability, and investigating these relationships in a different cultural setting in the Chinese context is meaningful. Thus, cross-border search capability is observed as a mediator in this study. It is essential to examine the content and motive for cross-border search capability, how and why digital transformation might react to cross-border search capability, and its effect on firm growth capability in the Chinese context.

Second, drawing on the RBV theory (Boadu et al., 2018; Rugman & Verbeke, 2002), this study incorporates into the framework three moderating variables of managers' digital concern, organizational agility and knowledge transfer dimensions on the relationship between digital transformation and cross-border search capability, and cross-border search capability and firm growth performance, respectively. The RBV addresses the heterogeneity of firms concerning their strategic and resource endowments and their strategic capability to exploit internal resources in the pursuit of a sustainable competitive edge, in contrast to the earlier focus in strategic management on the firms' adaptation to the external environment. Recognizing the fundamental evidence that firm-specific resources can lead to a sustainable competitive advantage, the RBV emphasizes how firms can secure resource-based rents by possessing valuable, rare, and inimitable resources (Barney, 1991; Wernerfelt, 1984). The current study contends that specialized skills or capabilities related to investment in digital transformation, managers' digital concern, organizational agility, and knowledge transfer dimensions can lead to firm-specific economic benefits for firms (McWilliams et al., 2006). Thus, managers' digital concern, organizational agility, and knowledge transfer dimensions could be justified as an investment in capabilities that will allow the firm to differentiate itself from its competitors and enhance organizational performance.

Based on RBV theory, this study proposes that managers' digital concerns described as the managers' commitment level and mental models for the organization's digital matters, are an important factor influencing digital transformation and its links with firm growth performance (Adner & Helfat, 2003). Digital transformation outcomes may vary depending on several contextual factors and play an important role in determining how organizations react to growth performance. Thus, the current study argues that managers' digital concerns can work with

digital transformation to promote firm growth performance via cross-border search capability. Hence, recent research suggests studies on the interaction effects of managers' digital concern and digital transformation on cross-border search capability.

Besides, the study proposes that organizational agility is described as the ability of organizations to sense and respond to environmental changes. It is an important determinant of organizational success that can influence digital transformation and its links with firm growth performance. Support for the direct effects of organizational agility on firm performance has been found in small, large, widely-held firms by several authors (Ganguly et al., 2009; Keshtegar & Seyedzadeh, 2014; Rostami & Hafizi, 2015). In their study, Keshtegar and Seyedzadeh (2014) discovered the linkage between organizational agility and firm performance. Rostami and Hafizi (2015) found a positive correlation between organizational agility and productivity. Nafei (2016) discovered a positive association between organizational agility and organizational success. From these studies, the researcher argues that organizational agility can influence cross-border search capability to affect firm growth performance. Indeed, from the extant works, the interactive effect of organizational agility and cross-border search capability on firm growth performance is scarce.

Finally, previous scholarships in the strategic management literature provide little understanding of how moderating effects of resources such as knowledge transfer dimensions, can influence the cross-border search capability-performance relationship. Extant works have established that contextual variables such as knowledge transfer contribute to the firm's innovative performance (Vijita Aggarwal & Kapoor, 2018; Vijita Aggarwal & Kapoor, 2020; Hamdoun et al., 2018). The study contends that knowledge transfer dimensions can work together with cross-border search capability to promote firm growth performance. From the extant studies, little empirical research has been conducted on the moderating influence of the knowledge transfer dimensions on the interplay between cross-border search capability and firm growth performance. In other words, the connections among the two dimensions have rarely been examined. Therefore, the current examination merits scholarly attention.

To sum up, this thesis will construct a research framework on the impact mechanism of digital transformation on firm growth performance. It focuses on exploring cross-border search capabilities, managers' digital focus, organizational agility, and knowledge transfer in this model. Relevant research will help with the insufficiency of existing research and bring important theoretical and practical value.

1.3 Research objectives

The study's general objective is to examine the impact of digital transformation on firm growth performance in scientific and technological enterprises in China, as well as the mediation role of cross-border search capability and the moderation role of managers' digital concern, organizational agility, and knowledge transfer dimensions. Based on the main objective, the following specific objectives are set to guide the study. The specific objectives of the study are to:

(1) Examine the impact of digital transformation on firm growth performance in scientific and technological enterprises in China.

(2) Assess the mediation role of cross-border search capability in the relationship between digital transformation and firm growth performance in scientific and technological enterprises in China.

(3) Assess the moderation effect of managers' digital concern on the relationship between digital transformation and cross-border search capability in scientific and technological enterprises in China.

(4) Assess the moderation effect of organizational agility on the relationship between cross-border search capability and firm growth performance in scientific and technological enterprises in China.

(5) Assess the moderation effect of knowledge transfer dimensions (i.e., explicit and tacit knowledge transfer) on the relationship between cross-border search capability and firm growth performance in scientific and technological enterprises in China.

1.4 Research questions

The following research questions guide the study in achieving the outlined objectives.

RQ1. What is the relationship between digital transformation and firm growth performance in scientific and technological enterprises in China?

RQ2. What is the mediation effect of cross-border search capability in the relationship between digital transformation and firm growth performance in scientific and technological enterprises in China?

RQ3. What is the moderation effect of managers' digital concern on the relationship between digital transformation and firm growth performance in scientific and technological enterprises in China?

RQ4. What are the moderation effects of knowledge transfer dimensions (i.e., tacit and explicit knowledge transfer) on the relationship between cross-border search capability and firm growth performance in scientific and technological enterprises in China?

RQ5. What is the moderation effect of organizational agility on the relationship between cross-border search capability and firm growth performance in scientific and technological enterprises in China?

1.5 Study methods

The quantitative method was applied, to test the hypotheses and establish reliable findings for the study.

The study gathered firm-level data from top executives of the scientific and technological enterprises of China through a survey research questionnaire to ascertain the interaction among the variables in the study, using a seven-point Likert scale. The seven Likert scale questionnaire items ranged from 1 Totally disagree to 7 Totally agree. The full-scale anchors were: 1. Totally disagree; 2. Strongly disagree; 3. Disagree; 4. Neither agree; 5. Agree; 6. Strongly agree: and 7. Totally agree.

This study inputted the data results into a statistical software package (SPSS) for analysis. The study engaged SPSS software to test mean, standard deviation, skewness, kurtosis, and exploratory factor analysis (EFA), including Bartlett's sphericity test and correlation between research variables. In addition, this study used a layer-by-layer regression method to determine the correlation coefficient and significance between variables. This study sent questionnaires in the form of questionnaires to enterprises in my workspace technology and other scientific and technological enterprises to collect relevant data.

1.6 Thesis outline and structure

This thesis is organized into five chapters:

Chapter 1 introduces the thesis and provides a comprehensive overview of the whole work. It covers the research background, problem statement, research objectives, research questions, summary of contributions or novelty of research work, research scope, and thesis structure.

Chapter 2 reviews the empirical literature of the thesis. Specifically, this stage exhibited a comprehensive literature review of all variables in the study framework.

Chapter 3 reviews the relevant theories related to the work. At this stage, the study

framework, hypotheses development, and settings are also observed.

Chapter 4 looks at the study methodology including research design, data collection procedures, questionnaire administration, population, methods, sampling procedures, measures, data processing, and analysis. These reports are based on the survey questionnaires administered.

Chapter 5 reports the data analysis and empirical findings of the research work. Tables and other relevant diagrams are used to make analytical relationships understandable and useful. Hypotheses testing and results are reported at this stage.

Chapter 6 reports the discussion, suggestions, and conclusions based on the research results of the thesis. Showcase theoretical contributions, managerial and practical contributions, research contributions and impacts on disciplinary knowledge bases, as well as the limitations and directions for future research on similar topics. The research work is comprehensive enough to cover the most important aspects of the topic.

Figure 1.1 shows the map of the research work.

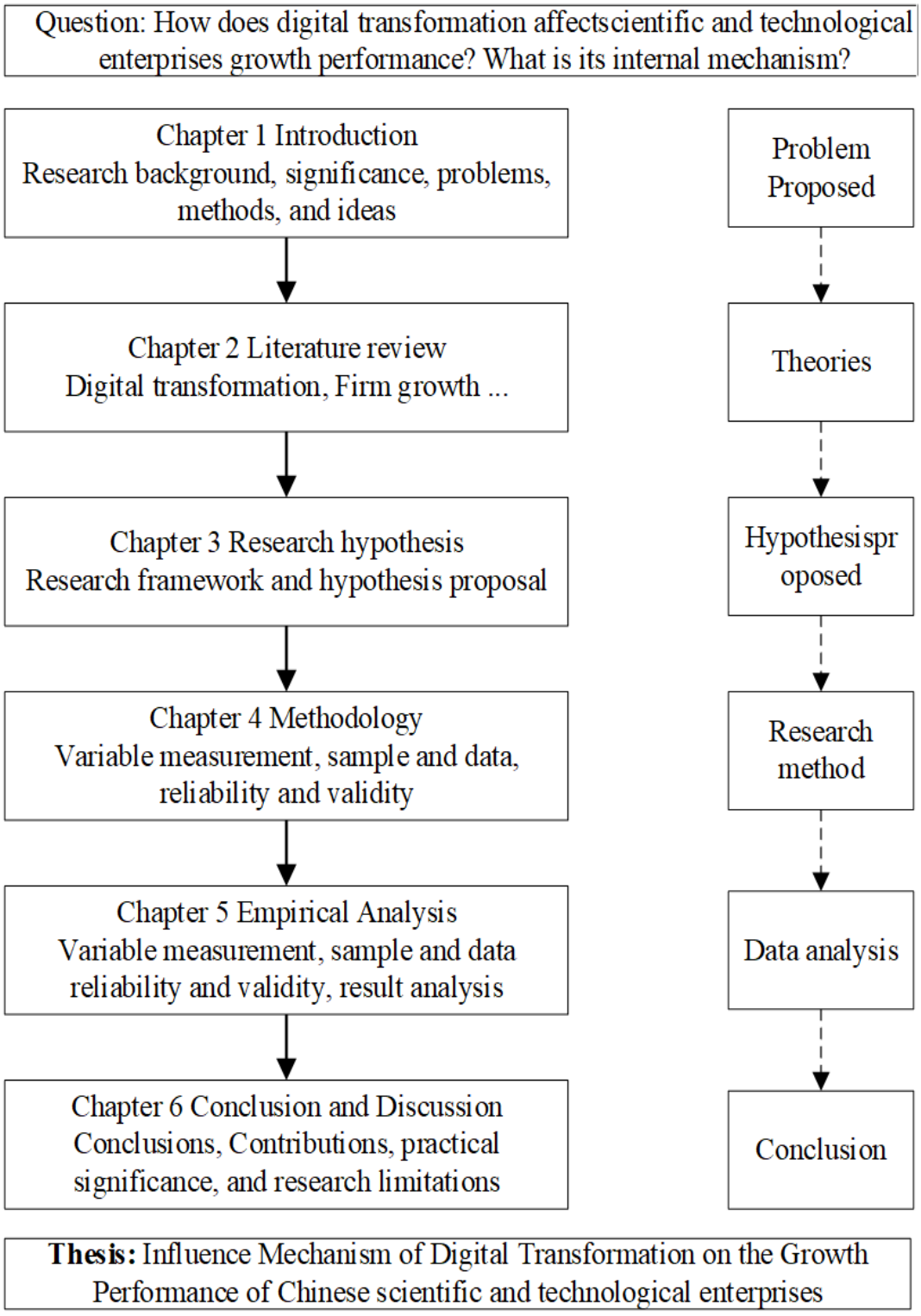

Figure 1.1 Research framework

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Chapter 2: Literature Review

Chapter 1 described in detail the background to the problem being scrutinized in this thesis. It set out the study aims, objectives, and research questions for the study. This chapter reviews pertinent literature. It covers a review of the concept of digital transformation, the definition of digital transformation and its dimensions, its importance as a source of competitive advantage, the definition of knowledge transfer, and the forms and strategies of knowledge transfers. The chapter discusses the performance concept and explores how digital transformation can contribute to firm growth performance from a strategic perspective.

In addition, this chapter delves into the discussion of cross-border search capabilities (the mediator), managers' digital concerns, knowledge transfer types, and organizational agility (the moderators) from a strategic perspective.

2.1 Digital transformation

2.1.1 Proposition of digital transformation

In the contemporary global digital economy, enterprises' reliance on bureaucratic control over intangible resources to accomplish a competitive edge, grander performance, and sustainability (Behnam & Cagliano, 2019) has shifted to a more holistic digitalization of their organizational design and decision-making. The similar viewpoints, Osmundsen et al. (2018) point out that digitalization has brought disruptive vicissitudes to many economies across the globe, and the concept is changing the way enterprises function in this day and age. Thus, to cope with the challenges of digitalization, enterprises engage in digital transformation to create value (Matt et al., 2015; Ross et al., 2016; Vial, 2021). Digital transformation enables an enterprise to exploit organizational resources, subsequently leading to a novel business model that improves the enterprise's competitive edge (Xie et al., 2022).

Digital transformation as an essential technological resource is a crucial element of organizational know-how in a digital economy (Xie et al., 2022). It has become one of the most strategically significant resources to change industries and businesses in the contemporary economy. Thus, the current works show that the digital transformation has brought disruptive changes to the economy and is shifting the approach enterprises operate these days.

Admittedly, these vicissitudes are pertinent for all levels of organizational decision-making:

On one hand, enterprises must ascertain apposite strategic retorts to the novel imperatives of evolving digital technologies (Sambamurthy & Zmud, 2000). For example, this encompasses digital business strategies (Bharadwaj et al., 2013; Mithas et al., 2013) and digital transformation strategies (Matt et al., 2015). Such strategies are business-centric and trans-functional (i.e., customer-focused), they postulate digital technologies' affordances at the core of business models, products, and services, and they recognize enterprises' roles as actors in digital ecosystems (Bharadwaj et al., 2013; Majchrzak et al., 2016; Matt et al., 2015; Ross et al., 2016; Ross et al., 2016).

Conversely, digital transformation has been linked with the establishment of associations with the enterprise's external actors, for which digital technology may aid as an enabler. As digital technology incessantly changes and fragments into fresh resources, it calls for enterprises to revolutionize with it to line up their activities so that a lively and heterogeneous base of facts and expertise can gain access to and in line with dynamic demands over time (Gimpel et al., 2018; Karimi & Walter, 2015). It may involve restructuring innovation configurations in the organization, shifting from static organizational units to swift cross-functional tasks to run into the set requirements of specific responsibilities (Rigby, 2014).

Thus, to support new products, services, and business models, and to empower and leverage vicissitudes to organizational structure, enterprises need to rearrange in-house actions, comprising procedures and practices in the course of digital transformation (Matt et al., 2015). It is also vital for operational structures to linger adequately steady and dependable to provide legacy business (Gimpel et al., 2018; Karimi & Walter, 2015).

In addition, by capitalizing on standardized digital infrastructure, enterprises may form or be engrossed in inter or intra-networks that can offer them paired know-how on a need-to-use basis (Andal-Ancion et al., 2003). In other words, enterprises' ability to apply and adjust infrastructure to provide novel forms of digital business and inter-organizational collaboration is related to greater enterprise performance.

Predominantly, digital transformation involves manifold initiatives to activate structural and contextual changes in enterprises (Berghaus & Back, 2017). For example, due to the holistic scope of organizational transformation, enterprises are introducing novel functions and duties such as the Chief Digital Officers (CDOs) (Horlacher & Hess, 2016; Tumbas et al., 2015) as a new management role within organizations that are often assigned to head digital transformation (Benlian & Haffke, 2016), they create new organizational entities for experimentation and digital innovation such as digital units (Jöhnk et al., 2017; Raabe et al.,

2020) , or they engage in a holistic change of their organizational culture (Duerr et al., 2018).

The predominant effect of these changes has been realized in heavily consumer-oriented industries such as music, publishing, consumer electronics, retail, and financial services (Hagberg et al., 2016; Kraus et al., 2022; Nasiri et al., 2020; Singh & Hess, 2020), but it has also started to affect the large manufacturing sector (X. Wang et al., 2017).

The significance of digital transformation has been accentuated by academics and business leaders (Morakanyane et al., 2017; Xie et al., 2022) in various fields of study. They have acknowledged the concept as an indispensable tool for sustaining enterprises' competitiveness, innovation, and survival in the global market. Therefore, drawing on existing scholarship in the digital transformation field, the phenomenon can be described as processes of essential organizational variation driven by the application of digital technology to nurture enterprises' innovation for value creation and annexation. Following this far-reaching depiction of the digital transformation concept, the succeeding section delves into various definitions of digital transformation.

2.1.2 Definitions of digital transformation

For the past two decades, scholars like Patel and McCarthy (2000) were considered the pioneers remarking on the concept of digital transformation but did not go as far as to conceptualize the term. Nevertheless, in recent years, the significance of digital transformation in business growth has received growing attention from academics and practitioners. Still, despite numerous scholars that have addressed this topic, a reconciled definition of the term is missing in the extant works (Morakanyane et al., 2017).

Thus, the fundamental concept of digital transformation lacks a clear definition and presents a conflicting perspective among academics and business leaders (Morakanyane et al., 2017). One of the foremost reasons could be that digital transformation comprehension calls for an interdisciplinary line of attack (Hausberg et al., 2019). Even in the new millennium, authors still have divergent views of digital transformation and its features. They see digital transformation as a complicated concept and have offered different definitions, as presented in Table 2.1. For example, Westerman et al. (2011) assert that digital transformation is the application of digital technologies such as the Internet of Things, cloud, big data, social networks, and mobile to enhance enterprises' performance.

Table 2.1 Definitions of digital transformation

Definition	Representative Study
“Digital transformation describes the process of utilizing digital technologies to trigger significant changes to companies’ value creation paths.”	Vial (2021)
“Digital transformation entails a significant enhancement of organizational capabilities as well as a new organizational identity.”	Wessel et al. (2021)
"Digital business transformation describes an organizational change that joins digital technologies and business processes into a digital economy with the purpose to improve performance and competitiveness.”	E. FitzGerald et al. (2013); Henderson and Venkatraman (1999); Wade (2016); Whyte et al. (2016)
“Digital transformation is the process of influencing changes to organizational structures and operations toward goal achievement.”	Matt et al. (2015)
“Digital transformation is about the vicissitudes related to the implementation of digital technology in all facets of human society.”	Stolterman and Fors (2004)
“Digital transformation is a process of using new digital technologies (social media, mobile, analytics, or embedded devices) to accomplish major business improvements (such as improving customer experience, streamlining activities, or creating new business models).”	M. Fitzgerald et al. (2014)
“Digital transformation describes an organizational strategy formulated and implemented on digital properties to generate distinction value.”	Bharadwaj et al. (2013)
“Digital transformation is the use of digital technologies, such as big data, cloud computing, mobile, digital twin, and social media platforms, to improve the core business of enterprises and other entities.”	Xie et al. (2022)

In addition, Lankshear and Knobel (2008) define digital transformation as the ultimate level of digital-savvy. Thus, the scholars explain that the concept enables novelty and ingenuity and fuels momentous vicissitudes in professional and knowledge spheres. In the same way, Stolterman and Fors (2004) describe digital transformation as the vicissitudes that digital technology stimulates in all facets of human life.

Admittedly, digital transformation is deeply associated with human actions. In a real-world situation, a human being transmutes actions (e.g., digital technology) and the process of creating value.

Digital transformation plays a significant role in the betterment of human lives. From the extant literature, few scholars (Nadkarni & Prügl, 2021; Vial, 2021; Wessel et al., 2021; Xie et al., 2022) have a robust definition of digital transformation. The current research depicts digital transformation as a comprehensive journey of organizational change, where the evolution of organizational strategies over time facilitates innovation and capture of value. Within the business sector, the core purpose of digital transformation for companies is to leverage digital

technologies and capabilities to enhance the consumer experience while exploring innovative business models that bring value creation across the system.

2.2 Main technologies related to digital transformation

Digital transformation is predominantly a change stemming from the progress of brand-new technologies (Henriette et al., 2016). Digital transformation is more than the application of technology; it is a change to a new business model and management philosophy. It involves maintaining a dynamic and sustainable competitive advantage through experimental innovation, incremental radical change, and through evolving temporary advantages (F. Li, 2020).

Over time, the concept of digital transformation is gradually transforming into a core driver of business growth. It's not just about innovations and breakthroughs in information technology; it's a deeper integration of cutting-edge technologies such as cloud computing, big data, artificial intelligence, and blockchain into business strategies, thus building an ecosystem that is both powerful and complex (Gong, 2022).The combined use of these advanced technologies has revolutionized the traditional modes of operation in the industry, leading to unprecedented changes in production processes, sales strategies, and management structures. In this new data-driven era, many organizations are adopting an "on-chain" strategy, i.e., building chains of digital assets to better allocate resources, improve efficiency and increase transparency.

At the same time, the concept of "going to the cloud" means that business processes and data storage will be migrated to the cloud to enhance competitiveness by utilizing the flexibility and convenience of cloud services. These measures undoubtedly bring substantial benefits to enterprises, not only in terms of lowering operational costs, but also in terms of speeding up the flow of information, which greatly accelerates the speed of innovation and market responsiveness (J. H. Wu & Duan, 2020). The evolving technologies such as the Internet of Things, cloud computing, social networks, and big data analytical applications offer game-changing prospects for enterprises to capitalize on the advantages of digital transformation (Sebastian et al., 2020).

2.2.1 Internet of things

Internet of Things (IOT) is a computing concept that explicates the linking of physical devices to the Internet and their ability to interconnect with other devices (Sade et al., 2015). Thus, the concept incorporates a diversity of network-connected equipment such as radiofrequency identification (RFID) and measuring devices, which can adjust to the world (Atzori et al., 2012).

Scholars have recognized the concept as a disruptive technology that is playing an active function in digital transformation and is driving the day-to-day lifecycle, enterprise activities, and international market arena in recent years (Paul et al., 2021). Admittedly, the Internet of Things is a ground-breaking technology with espousal in innumerable fields; It is projected that 30 billion parts in 2022, from 0.9 billion in 2009, will get access to the Internet of Things. Besides, it is projected that enterprises will upsurge their connectivity outlays by 15% per annum through 2022 (Shim et al., 2019). Additionally, the market for Internet of Things devices has boosted the quantity of Internet of Things devices to 7 billion in 2018; it is anticipated to surge to 10 and 22 billion by 2020 and 2025, respectively (Mohankumar & Kumar, 2016).

From the business point of view, the aim of executing the Internet of Things is to digitalize the outdated product-oriented businesses in the direction of a data-driven to add value to products or services available (Shim et al., 2019). The concept has contributed immensely to many application fields in organizational development. Shim et al. (2019) categorized into two groups: customer Internet of Things and Industrial Internet of Things, respectively.

The former takes account of common devices applied by the final user; basically, it is the gathering of peculiar facts from the consumer and constructing intelligent applications on the information modified to the consumer's desires and underlying forces of the environment (Papadopoulou et al., 2017). For instance, the envisage of pervasive healthcare to provide improved healthcare via a patient-centric way out empowered by the Internet of Things employing body part radars to unceasingly screen and assemble information to detect illnesses (Atzori et al., 2012; Shanmugasundaram & Sankarikaarguzhali, 2017).

Additionally, the regulation of household appliances (e.g., freezers and air conditioners) from a central regulating socket via an Internet of Things allowed wireless solution will permit improved household and energy administration (Alkar & Buhur, 2005). On the other hand, Hargreaves et al. (2018) contend that the espousal of the shrewd household is more sluggish than anticipated as they are both technically and socially unruly, and their practice can be restricted by the alteration and habituation of householders, and absence of support accessible for learning how to apply shrewd household technologies. The latter is a gathering of information from organizations' networks and smart-based applications to take advantage of the alteration of industries (Papadopoulou et al., 2017). The implementation of smart city environs provides numerous influences on inhabitants, comprising pro-land management, quality drinking water, and smart transformation schemes, among others (Gubbi et al., 2013). The concept can be useful in utilities to recover data from the system to improve service optimization (Papadopoulou et al., 2017), but simultaneously, it provides the perspective for

well-organized energy resource management via the setting up of smart networks to condense energy destruction and smart meters to match up energy demand and supply (Gubbi et al., 2013). Furthermore, it can be useful for quality assurance of drinking water as radars can be set up to safeguard supply excellence (Gubbi et al., 2013) and to monitor pro-land activities as a data grid for improved data-based agricultural assessments (L. Q. Zhao et al., 2011). In addition, mobile Internet of Things appliances can be constructed by the information gathered from mobile nodes (e.g., smart transformation scheme) (Papadopoulou et al., 2017).

Another application of the Internet of Things mobile domain is effective logistic management, including item monitoring and transportation planning (Gubbi et al., 2013).

Gubbi et al. (2013) assert that the mobile Internet of Things is active in logistic management for monitoring and transportation schedules. Effectual transport scheduling via a hefty grid of the Internet of Things can offer numerous advantages for logistics suppliers, such as condensed delivery costs by circumventing overfilled segments and enhancing the service value by supplying goods within the necessary period (H. E. Lin et al., 2005). The novel prospects of the Internet of Things are that organizations can enhance their output, lessen operational outlays, and boost client service experience (Shim et al., 2019). The Internet of Things can surge output by offering facts that can make decision-making more rapid and well-organized (Garg et al., 2017). For instance, Safexpress, one of the leading supply chain enterprises in India, utilized the Internet of Things (i.e., they set up GPS and GPRS equipment) to enhance the load factor of vehicles and condensed the interruptions radically to catch a precise time of shipments influx (Murgai, 2018). In addition, Internet of Things research conducted by Harshani et al. (2018) on agricultural lands revealed that crop output can be improved by observing soil parameters via diverse measuring devices. Y. S. Tan et al. (2017) studies revealed that enterprises' adoption of Internet of Things-endowed energy efficacy control panels leads to lesser operational outlays. They assert that the Internet of Things can present actual energy consumption to enhance energy management and eradicate energy surplus. Moreover, the espousal of the Internet of Things can enhance the client expedition, and one of the businesses that are functioning vigorously in improving active punter experience is retail businesses (Vargheese & Dahir, 2014). The incorporation and computerization motivated by the Internet of Things substructures (e.g., video cameras and RFID schemes) have helped vendors to get the out-of-stock levels close to zero and lesser the present 42% fortuitous that punters will bump into an out-of-stock circumstance (Vargheese & Dahir, 2014).

In today's digital age, IoT technology has become a major force for innovation and growth in business. However, X. Zhang and Wen (2017)'s research points out that many businesses

still cling to a conservative cost-center model that often fails to fully recognize the full potential of the IoT as an enabler of a new kind of consumer concentration. First, we must recognize that the IoT is not just a technology, but a new business model. It enables the collection, analysis and utilization of data by connecting various devices and systems to provide more personalized and efficient services. For example, with IoT technology, companies can monitor product usage in real time, gain insight into consumer needs and preferences, and provide more accurate products and services. However, to fully harness the potential of IoT, companies must break away from the traditional cost center model and create a breakthrough business model. This model should be customer-centric, offering greater performance output and customized services by applying the ubiquitous and ubiquitous nature of IoT. For example, companies can use IoT technology to improve customer satisfaction and loyalty by enabling remote control and maintenance of products and providing 24-hour customer service. In addition, IoT technology can help companies achieve digital transformation. By synthesizing a vibrant environment in each IoT application area, enterprises can automate and optimize business processes to improve operational efficiency and competitiveness. For example, through IoT technology, enterprises can realize real-time monitoring and management of the supply chain, reducing inventory costs and risks (Ju et al., 2016).

In conclusion, Internet of Things technologies will drive the digital transformation and provide an extensive variety of prospects to form groundbreaking business models by synthesizing an energetic environment in each Internet of Things application sphere (Papadopoulou et al., 2017).

2.2.2 Cloud computing

The advent of cloud computing epitomizes a significant alteration for information technology (IT) services since it provides anytime and anyplace storage (Marston et al., 2011). Cloud computing refers to an IT service model that offers on-demand intake and actual distribution admittance to computing resources comprising grids, storage, and servers (Berman et al., 2012; Dillon et al., 2011). The concept provides on-demand computing resistor without putting in new structure, licensing software, and fresh workforces (Knorr & Gruman, 2008).

Cloud computing is also an emerging computing model that builds on grid computing to provide dynamic, elastic, and often pay-as-you-go computing resources and information over the Internet (Han, 2019). This model of computing allows users to use computing resources as if they were public utilities without having to care about the specifics of the underlying hardware and software (Mandeep & Kaur, 2013). The core features of cloud computing include

scalability, high availability and optimal resource utilization (K. Chen & Zheng, 2009). At present, Amazon, Microsoft, Google, IBM and Intel and other well-known enterprises have put forward the "cloud program". For example, Amazon launched AWS (Amazon Web Services), IBM and Google jointly launched the "Blue Cloud" program. These initiatives have greatly affirmed the commercial value of cloud computing.

At the same time, academics have also conducted in-depth research on cloud computing. For example, Google and the University of Washington and Tsinghua University launched a cloud computing academic cooperation program to promote the popularity of cloud computing and strengthen its research. Carnegie Mellon University and other organizations have conducted research on data-intensive supercomputing, which is essentially a study of cloud computing-related technologies (Q. Chen & Deng, 2009). Enterprises accepts the cloud as an approach to condense costs and intricacy related to conservative IT management (Berman et al., 2012). In addition, the future of the concept is lively as it is anticipated that by 2023, more than $1 trillion will be applied by organizations unswervingly or circuitously in IT outlays to transmute to a cloud computing structure (Senyo et al., 2018).

Cloud service distribution models can be classified into three mutual zones: Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS) (DaSilva et al., 2013; Kaur & Chana, 2016; A. Lin & Chen, 2012). First, SaaS offers enterprise applications held by the cloud supplier and dispersed via the internet (X. Xu, 2012). The advantages of the SaaS model are that it eradicates the necessity for the handler to manage multifaceted applications and permits the supplier to issue updates to the enterprise (Prasad et al., 2014). Examples of SaaS suppliers comprise Google Mail and Documents, NetSuite, and Microsoft Office Live (X. Xu, 2012). Secondly, PaaS is an advancement and implementation platform that offers designers admittance to hosting, user interface design, apparatuses, and management setting (Dillon et al., 2011). One benefit of the concept is its ability to offer complete lifespan software improvement, permitting designers to distillate more on prolific hitches rather than management hitches (H. B. Yang & Tate, 2009). Examples of PaaS suppliers comprise Google App Engine and Facebook F8 (X. Xu, 2012). Thirdly, IaaS offers IT enterprises and software designers a secluded, complete IT structure comprising storage, computing capabilities, and equipment (Y. Liu et al., 2016). The advantages of IaaS are that it allows the effectual application of IT properties via scalable virtual machines that match the computing demands and eradicates the necessity for enterprises to form and manage IT structures (Dillon et al., 2011). Examples of IaaS suppliers include Amazon Elastic Compute Cloud (EC2) and Simple Storage Service (S3) (H. B. Yang & Tate, 2009).

These three zones present a computing paradigm shift as IT properties are no longer measured as products but as services that can be rented from clients via the Internet (Y. Liu et al., 2016). Besides, cloud computing can be grouped as private, community, public, and hybrid cloud based on the linkage between the user and the supplier (H. B. Yang & Tate, 2009).

The distinct characteristics of cloud-like cost-effectiveness, swift accessibility, market adjustment, disguised intricacy, user-friendliness, and network accessibility offer novel prospects and business worth (Berman et al., 2012). First, cost-effectiveness allows enterprises to change IT capital outlays, which are servers, software licenses, and networking apparatuses to operational outlays (Saxena & Pushkar, 2016). This indicates that cost-flexibility makes a near-to-the-ground barricade to entry that will permit enterprises to have instantaneous admittance to computing capabilities without the necessity to put in capital investments (Marston et al., 2011). Still, the pay-as-you-go billing model offers clients properties such as storing in the form of computer-generated apparatuses that are robustly allotted and disallowed. Thus, clients pay based on the amount and the time length of assets usage (Mei et al., 2018). Studies conducted by Berman et al. (2012) concerning the pay-as-you-go model on world business captains revealed that more than thirty-one percent consider the model as one of the foremost advantages of cloud computing. For instance, the model condenses the structure and maintenance budgets of the Commonwealth Bank of Australia by 40 %. It also reduced the expansion of fresh IT-enabled products and services (Sumner & Caro, 2018). Second, the scalability characteristic of cloud computing makes it stress-free for enterprises to augment or eliminate dynamic resource capabilities in the actual period (Marston et al., 2011).

The speedy running of assets with no scale boundaries allows firms to benefit from economies of scale without making capacity precommitments (Berman et al., 2012). For firms, auto-scaling denotes meeting the punter's request at the appointed time by having the servers on the go as needed in periods of unanticipated request or the course of the crowning periods (Fazli et al., 2018). In a real sense, the internet on-demand streaming supplier of silver screen and small screen shows Netflix faces huge increases of requests in the crowning hours between 9 and 12 pm; as a result, they resolved to transfer their website and streaming services via a cloud setting (Müller et al., 2015). The change to cloud computing permitted Netflix to not just bump into the request of the prevailing punter base but also to develop and increase unceasingly and to meet its development desires (Berman et al., 2012). Thus, the cloud’s fitness to scale capabilities to assist well-organized evolution is distinguished as one of the highest advantages of cloud computing (Müller et al., 2015). Third, cloud computing surges the dexterity of enterprises to acclimatize to speedily mutable market demands by easing invention and

plummeting period to market (Berman et al., 2012). For instance, Clear DATA and Google Cloud combined to fast-track modernization in healthcare by permitting designers to enlarge their research and find novel healthcare implementations via a protected and acquiescent health data setting and a far-reaching open-source structure with automatic deployment and scalability.

Additionally, cloud computing aids the haste period to market as machinists of cloud computing assets, in many cases do not want to acquire, connect, and trial the whole structure comprising middleware and applications (Marston et al., 2011). In real terms, Active Video used the cloud power to augment market malleability by synthesizing a cloud-based small screen that releases the consumer boundary from the gadget by transferring the application engine to the cloud and merges diverse sources and formats of content comprising Web, small screen, social, mobile into any video screen to offer audiences a novel television understanding (Berman et al., 2012).

Fourth, cloud computing provides the disguised intricacy benefit that permits enterprises to hide the ins and outs from the final consumer as renovations. The upkeep can be executed in the context deprived of demanding whichever contribution from the final consumer (Berman et al., 2012). For instance, the concept works well in real-life situations, especially, the espousal of cloud computing in laser printing, as the intricacy of big data management in keeping official papers, altering them to print-ready format, and dispensing them to the laser copier is concealed by permitting the final consumer to print straight from smartphones, notebooks, and other devices (Rudra, 2020).

Fifth, the cloud can hoard a huge quantity of data that can be applied to comprehend clients and their purchasing lifestyles to allow customization of products or services (Marston et al., 2011). Studies conducted by Berman et al. (2012) revealed that more than fifty percent of business executives selected this cloud element as vital for enterprise development.

Sixth, network connectivity empowered by the cloud can take along clients and cohorts to expedite outside alliances to advanced output and upsurge innovation (Berman et al., 2012). This grid-built structure can offer enterprises the prospect of cultivating inter-organizational linkage amongst cohorts by exchanging resources and offering a right of entry to material and procedures to promote organizational activities (Iyer & Henderson, 2010). A typical example of this feature is the B2B amalgamation dais established by “Gist” (one of the leading logistics enterprises in the UK). The system brings onboard wilder trading associates and offers suppleness in treating fresh partner communication desires (Y. Liu et al., 2016).

2.2.3 Social media

Social media as a concept is speedily altering the method of how we communicate and cooperate (Aral et al., 2013). For the past few years, enterprises communicated exclusively via conservative modes comprising head-on meetings, e-mails, and written communiqué that restricted the movement of information to a trivial subset of persons. The mechanism of information dissemination in social media is one of the focuses of research. Online social networks have become an important channel for information dissemination, and research efforts have been devoted to understanding information dissemination in online social networks, including popularity prediction, dissemination modeling, information traceability (C. J. Hu et al., 2017). Nonetheless, currently, the coming of social media daises allows enterprises to expedite communiqué amongst peers and simultaneously drive enterprises to a different level of the ladder (Ganis & Marimekala, 2014). The virtual insurgency of social media is pioneered by young individuals and in recent years scholars have acknowledged that people of all ages are joining the train (including baby boomers) as users of social media (Berman et al., 2012). In 2017, the users of social media across the globe were a whopping 2.46 billion people and it is anticipated to be 3.02 billion people in 2021. The global penetration of social networks is swelling as in 2017, 71 percent of internet users had a social media account. In addition, social media networks have become the main communication platform for emergencies, and the influence of online public opinion has been spread and disseminated on a wider scale (M. Y. Wang & Chen, 2017).These studies have shown that social media have a unique role and impact in the dissemination of information. Social media user behavior is also a key area of research. As social platforms and applications are constantly being updated, different groups of people will have different application styles and behaviors (Watson, 2024). From the perspective of social impact theory, the study of social media user groups' continuous use behavior and its changing law provides reference suggestions for social media operators in platform design and management policy (Xiao et al., 2017).

In March 2019, within one minute, there were 4.5 million videos watched on YouTube, 2.1 million Snaps created on Snapchat, 1 million Facebook logins, 347,222 users scrolling Instagram, and 87,500 people tweeting on Twitter (Rapinel et al., 2019). Altogether, active users of social media are creating a huge size of exclusive day-to-day content that permits influential market research information around their penchants, conducts, demographics, and dealings.

This huge size of information offers the exceptional prospect to mine and read between the

lines using statistical techniques buttressed by exhaustive computing structures (Berman et al., 2012). Thus, social media is an important element of all the digital transformation that is taking place across businesses (Ganis & Marimekala, 2014). Enterprises apply social media aspects to stimulate their brand, connect with their clients, and co-create add-ons and novel facets that can add to the advancement of social media (Ganis & Marimekala, 2014). Dou et al. (2013) assert that enterprises can reinforce their linkage effects by entrenching social media aspects at the usefulness level comprising communiqué aspects (e.g., chats and teamwork) and co-creation aspects (e.g., content editing and labeling).

Besides, enterprises are applying social media to boost knowledge management and teamwork efforts within the organization (Benbya & Van Alstyne, 2010). Enterprises used to send communications to the punter via well-organized marketing plans and sales channels, but nowadays, they are exploring the application of social media to create cognizance and to influence punters for a specific item for consumption (Ganis & Marimekala, 2014). For example, certain enterprises are applying virtual assessments of the enterprise as a strategic advantage to sway consumers' purchase decisions, while others are engaging in social media marketing to construct customer fidelity (Kumar et al., 2013). Social media have transformed enterprises' way to the open market; it offers a novel world of potential for organizations (Aral et al., 2013). Enterprises are applying network-based marketing to benefit from the social network to boost brand recognition and proceeds. The three approaches of network-based marketing are explicit advocacy, where persons endorse a product or service to their associates; implicit advocacy, where a person campaigns for a product covertly; and network targeting, which is applied to market to prior procurers' social network neighbors who are 3 to 5 times more probable to espouse a service compared to a reference point assemblage (S. Hill et al., 2006). Likewise, Aral and Walker (2011) posit that enterprises can synthesize word-of-mouth peer effects by scheming viral aspects in their products. The authors' survey of 1.4 million friends of 9,687 users on Facebook revealed that passive-broadcast viral aspects synthesize a surge of 246 percent in peer effect and social infection. Thus, the conclusions have far-reaching insinuations for executives to support viral product dissemination as a portion of their marketing tactic to synthesize social infection. Moreover, enterprises like Ford Motor, Southwest, and PepsiCo are scrutinizing the posts and tweets put out on Facebook and Twitter to measure the influence of their marketing drives and to better comprehend how their brand mawkishness is altering amongst the clients (Bughin et al., 2013).

Additionally, social media can be applied to forecast punter requests (Aral et al., 2013). Asur and Huberman (2010) scrutinized the predicting influence of social media by making a

linear regression model investigating three million tweets from Twitter concerning 24 diverse movies to forecast the box-office proceeds before their announcement. The outcomes produced projected the proceeds for the movies with better precision than those on the Hollywood Stock Exchange. Aral et al. (2013) argues that the social media revolution drives further than the marketing and consumer behavior phase. The concept is progressively transmuting the approach enterprises connected to the labor force. It allows them to create flexible dealings with outside distant talent. It is also applied to crowdsourcing new ideas. For instance, MyStarbucksIdea, an online community established in 2008, invited final consumers to submit novel concepts to advance products and services. Until 2012 it produced more than 150,000 thoughts, 277 of which were executed (H. J. Lee & Suh, 2014). For the internal purposes of enterprises, the concept can alter the sharing of knowledge and experience (Aral et al., 2013). Benbya and Van Alstyne (2010) contend that inner knowledge markets can simplify knowledge transfer within big organizations and protect enterprises with a huge sum of cash from the technical maintenance budgets. Besides, it offers a model of how SAP, a software enterprise, expedites peer-to-peer retorts amongst software designers in the enterprise via a knowledge market. As a result, this system of Q&A empowered the enterprise to protect more than $6 million from technical maintenance outlays. Furthermore, social media can fast-track the growth of novel and groundbreaking products (Aral et al., 2013).

2.2.4 Big data

With the rapid development of information technology, especially the wide application of cloud computing, Internet of Things, mobile Internet and other technologies, the type and scale of data in human society are growing at an unprecedented rate, thus giving rise to the arrival of the era of big data (Y. Liu & Zhang, 2016). Scholars have acknowledged big data as a vital subject in information systems, business, and social science as it is altering the approach to how information is created and made pertinent (Constantiou & Kallinikos, 2015). The concept of big data initially only refers to the huge scale of data, however, with the continuous development of big data management technology, this simple definition can no longer fully cover the connotation of big data. Emphasizing only the huge scale of data does not seem to change the previous data management in essence. Therefore, the specific concept of big data should include all the characteristics of its data processing. The current widely recognized definition of big data is: a data management model that realizes high-speed processing of data on the basis of a huge quantity, complex type and high value content of data and information (Meng & Ci, 2013). The concept is mainly a consequence of the extensive espousal of mobile

devices, social grids, the Internet of Things, and other unified information systems (Mikalef et al., 2018). From the extant works, authors have given diverse definitions of big data. For instance, some scholars accentuate the conduits of data generation such as smart meters, manufacturing sensors, weblogs, social media feeds, GPS signals, and other network devices (Opresnik & Taisch, 2015; Wamba et al., 2015) while certain authors stress three "Vs": volume, velocity, and variety (De Mauro et al., 2016; Kwon & Sim, 2013; McAfee et al., 2012). George et al. (2016) describe the volume as a huge amount of data that is a consequence of the combination of a great number of variables. This huge size of data consumes a vast storage capacity. For example, it is projected that Walmart's data warehouse can collect 2.5 petabytes of information every 60 minutes (McAfee et al., 2012), while Tesco creates 1.5 billion new items of data once a month (Wamba et al., 2015). George et al. (2016) describes the haste with which data are gathered and examined (George et al., 2016).

In the actual period or close period, information is a vital element in allowing actual period activities and policymaking and making it conceivable for enterprises to develop their suppleness (Mikalef et al., 2018). Wamba describes the multiplicity of data origin and set-ups that embraces organized and formless data in the script, imageries, audial, cinematographic, and visual aid set-ups (Wamba et al., 2015). Besides, several authors have also counted on diverse facets of big data to supplement the three "Vs" aspects (Mikalef et al., 2018). For example, veracity is an additional recognized feature of big data and denotes the superiority of data, level of trust in diverse bases, and level of safeguard from not approved right of entry and alteration (Demchenko et al., 2013). It is a vital characteristic as data should be realistic and official via quality acquiescence measures before the organization applied them to make verdicts on business worth (Akter et al., 2016). Drawing on these definitions, value was added to the definition of big data to focus on the significance of digging out economic advantages from the data (Wamba et al., 2015), and later on Kwon et al. (2014) and Lamba and Dubey (2015) incorporated the dimensions of variability to denote the clarification of the same data in diverse approaches and conception. The early description of big data grounded on the data and its features has been protracted by certain scholars who have also incorporated the analytical methods, skills, and mechanisms (Kwon et al., 2014; Lamba & Dubey, 2015).

Big data in terms of business analytics describes "an all-inclusive line of attack to cope, practice, and scrutinize data, not only to make actionable comprehensions but also to allow enterprises to forecast vicissitudes grounded on market desires and retort to them rapidly" (Ashrafi et al., 2019). Besides, the analytical approach, the description of big data analytics by Kwon et al. (2014) comprises the components of apparatuses such as databases and data mining

that enterprises apply to examine vast gauge and multifaceted data. Hence, the explanations of big data analytics embrace a varied list of components that are crucial to the triumph of big data, but they do not comprise the enterprise operations and resources that are necessary to capitalize on big data (Mikalef et al., 2018). To completely grasp the advantages of big data resourcefulness, enterprises should change the concentration from the big data know-how apparatuses to the managerial and policy effects of big data analytics (Y. C. Wang et al., 2018). To address this subject, certain scholars applied the concept of big data analytics capability to describe the procedure that can allow enterprises to apply intuitions from big data to make conversant conclusions that synthesize business worth (Lyu et al., 2014) while some authors stress the significance of investment in managerial resources to benefit from tactical and operational intuition (Hong et al., 2017). In principle, the concept of big data analytics capability comprises entirely connected managerial resources to power big data; it is separated into three kinds: tangible resources, intangible resources, and skills and knowledge (Mikalef et al., 2018).

First, tangible resources describe the features of data and structure that can assist data storage, distribution, and scrutinizing. The assortment and scope of data origins that enterprises leverage currently makes the feature of data quality extremely significant and surges the apprehensions among experts about the quality of the data they scrutinize (Mikalef et al., 2018). Data quality is described in terms of comprehensiveness, format, correctness, and legal tender offered by analytics. It is a crucial asset to improve the business worth and create a competitive edge (S. J. Ren et al., 2017). One more feature of data is the subject of data accessibility and incorporation from diverse bases (Wamba et al., 2015), as it is common for enterprises to exchange data and create associations with other enterprises to benefit from intuitions about their clients and activities (Mikalef et al., 2018). Even though the data is a crucial asset, it is significant for enterprises to have a structure that can assist scalability and connectivity because of the huge quantities of varied and speeding data (Gupta & George, 2016).

Second, intangible assets such as governance and data-driven culture are predominantly momentous assets in receiving the paybacks from big data (Mikalef et al., 2018). Governance is a method that analytics-based enterprises take to describe, rank, and track analytical inventiveness (Espinosa & Armour, 2016), and firms must follow a top-down method where the executive needs a commitment to data-driven conclusions to effectually influence the big data (Vidgen et al., 2017). A data-driven culture is another vital intangible asset for the complete triumph since a huge amount of enterprises execute big data projects, and a massive preponderance of them bank on managerial experience or instinct to make enterprise verdicts

rather than on information dig out from data (Gupta & George, 2016).Third, human abilities and knowledge resources are indispensable to applying big data know-how and apparatuses and making strategic conclusions grounded on information (Mikalef et al., 2018). The aptitude to comprehend business complications and apply pertinent data origin to create intuitions via models and visualization apparatuses will not only be an essential ability for data genius but all workforces in an enterprise (Michael, 2014). Conversely, it is protruding that there is a dearth of workforces with applicable analytical abilities as the MIT Sloan Management Review report asserts that more than 40% of firms are not capable of discovering and keeping data science talent even though the European Commission guesses that by 2020 there will be a skills gap of 500,000 ICT specialists (Mikalef et al., 2018). Of specific significance for workforces involved in big data analytics are also the practical skills like the ones of big data engineers who code data from diverse bases and set-ups and execute data purgative and correspondingly the practical skills of big data designers who create plans for data sources among others (Mikalef et al., 2018).

Lastly, a significant skill that data experts should have is the aptitude to comprehend the aim and track of the enterprise and to detect how to gauge and increase key performance pointers (Gupta & George, 2016). Investment in big data analytical capabilities has exposed the prospective for alteration of the mode enterprises conduct business (Akter et al., 2016). From the extant work, big data analytical capabilities are considered the ensuing immense item in innovation (Gobble, 2013) or the succeeding management uprising (McAfee et al., 2012). Numerous scholarships have established the value creation from big data ingenuities (Opresnik & Taisch, 2015; Wamba et al., 2015; Y. C. Wang et al., 2018), whereas Wamba et al. (2015) categorized the value creation from big data into five ranges comprising transparency, experimentation and performance, segmentation, decision making, and new business models. Big data analytics can create business value by creating transparency via operative dashboards that boost policymaking (Meredith et al., 2012). For instance, enterprises in the supply chain are increasing transparency via big data to dispel sustainability risks and to enhance teamwork and communiqué with both upstream and downstream trading cohorts (S. N. Zhu et al., 2018). Big data can allow research to realize requirements and capriciousness and enhance performance (Wamba et al., 2015). Experimentation can take many forms as leading online enterprises conduct research by allotting certain Web page visits to comprehend what pushes consumer involvement or sales promotion, whereas enterprises selling physical goods like McDonald’s have connected apparatuses that gather active data in some of their stores to trail punter exchanges and collation designs (Wamba et al., 2015). Also, big data permits the

subdivision of the populace to make special activities (Wamba et al., 2015). For example, Aetna, a health care enterprise, has developed its business by detecting novel subdivisions via scrutinizing data at the punter level in contrast to the prior method of scrutinizing combined data at the account level (Beath et al., 2012). Big data can assist executives in making good verdicts or, in some cases, substitute the human factor in policymaking with automated algorithms (McAfee et al., 2012; Wamba et al., 2015). studies on 330 enterprises in North America revealed that enterprises that associate themselves with data-driven performance are better in terms of financial and operational than those who do not associate themselves.

In conclusion, big data has steered the growth of novel business models (Wamba et al., 2015). For example, commercial airlines constantly whined that the projected period arrivals offered by pilots were not entirely precise. An enterprise named PASSUR Aerospace took this prospect by bringing on board a service called Right ETA that eradicated the huge gaps amongst real and projected periods of arrival by applying and scrutinizing diverse data such as weather data, flight schedules, and radar stations data among others (McAfee et al., 2012).

2.2.5 Artificial intelligence

Artificial Intelligence, a dynamic and cutting-edge field of science and technology, is growing at an unprecedented rate and showing its great potential and value in various industries. The field is dedicated to developing theories, methods, technologies, and application systems that can mimic, extend, and even surpass human intelligence. Its research goal is to create intelligent bodies that have the ability to hear, see, and express language, can think and learn, and can act autonomously (T. Tan, 2019). Over time, artificial intelligence technology has experienced great progress. Thanks to the significant increase in computing power and the accumulation of massive amounts of data, AI is moving towards greater precision and efficiency (L. Zhang et al., 2024). However, early artificial intelligence did not fully realize the accurate replication of the basic laws of human cognitive processes due to the limitations of the knowledge and technology level at that time. With the continuous evolution of technology, the new generation of AI technology has begun to utilize technologies such as intelligent perception, the Internet and big data analysis to build intelligent models based on a large amount of empirical data. By digging deeply into these empirical data and adopting methods such as deep learning to extract knowledge and experience, the basic theories and laws underpinning intelligence are then refined (X. R. Huang, 2019). As AI technology continues to advance, it has become a common focus for both the state and the industry. The Digital China Strategy launched by the Central Committee of the Communist Party of China (CPC) and the State Council explicitly requires

that AI technology can provide empowerment to the real industry and promote the digital transformation of the industry (Z. M. Yang, 2023). The new generation of artificial intelligence is expected to play the role of an efficiency valve in the three key areas of content production, industrial integration and industrial transformation, to promote the in-depth optimization of the national innovation system and to improve the transformation efficiency of the national innovation system. At the same time, the new generation of AI can also provide new ideas for the output of innovation results for diversified innovation subjects, broaden the path of results conversion, and inject new impetus for socio-economic development (J. Zhang, 2024).

Currently, deep learning, as a hotspot in the field of artificial intelligence, has received widespread attention and research since it was proposed by G. E. Hinton and others at the University of Toronto in 2006 (Hinton et al., 2006). Deep learning refers to a machine learning technique which is based on artificial neural networks. The core idea is to utilize multi-level neural network structures to process information and extract features. These networks are made up of numerous neurons, each of which receives data inputs from the previous layer of neurons and converts them into actual outputs through a specific activation function (J. X. Zhao & Hao, 2024). This technique processes data by mimicking the way neurons work in the human brain, allowing machines to learn and understand the meaning of the data more efficiently. Taking image data as the object of study, the primate visual system follows the following steps in processing such signals: first, it detects the edges and initial shape of the signal, and then gradually forms a more complex visual form. Similarly, deep learning forms more abstract high-level representations, attribute classifications, or features by integrating low-level features and providing a hierarchical characterization of the data (Yin et al., 2015). Deep learning has demonstrated outstanding performance in a number of application scenarios, especially in the areas of image recognition, speech recognition, image classification, and gaming intelligence, where it has made impressive breakthroughs (Smolensky et al., 2022).

In addition, current research focuses on other AI areas such as machine learning, natural language processing and robotics (X. L. Zhu, 2023). The so-called "machine learning" is the full use of recognition means, mainly two kinds of recognition means, namely, knowledge recognition means and system recognition means, so that the mechanical learning ability has been improved, in order to obtain new knowledge in the operation of the machinery, to fully grasp the new technology, improve the ability level of these areas of research not only to promote the development of artificial intelligence, but also to lay a solid foundation for its wider application in the field of artificial intelligence. The research results in these fields not only promote the development of artificial intelligence, but also lay a solid foundation for its

application in a wider range of fields (Y. Tao et al., 2020). Currently, deep learning techniques based on artificial neural networks (ANNs), which belong to the category of machine learning, are the hottest research area in the direction of artificial intelligence, and are widely used by Google, Facebook, IBM, Baidu, NEC, and other Internet companies for image and speech recognition. Artificial neural networks emerged from the 1980s, through the unremitting efforts of scientists, the relevant algorithms are constantly being optimized and are in the process of continuous improvement and innovation, but also benefited from the rapid development of computer technology, scientists can now build super-large artificial neural networks through the GPU simulation; the rapid development of the Internet industry, which provides millions of samples for the deep learning of the training in the above three factors together, now the deep learning of speech recognition is the most important area of research. Under the combined effect of the above three factors, speech recognition technology and image recognition technology can now achieve more than 90% accuracy (J. Y. Liu, 2018). Machine learning is an inevitable outcome in the development process of artificial intelligence and therefore needs to be given high priority (Shi, 2021). With continuous technological advancement and sustained innovation, AI has become an important force for social change. Its application areas are expanding at an unprecedented rate, covering everything from intelligent transportation systems to personalized shopping recommendations. In terms of autonomous driving, driverless cars are gradually integrating into people's daily lives, improving transportation safety and reducing traffic congestion. Intelligent recommendation systems provide accurate content and services to users by analyzing user data and behavioral patterns, greatly enhancing the user experience. In the field of healthcare, AI technology is widely used in key aspects such as assisted diagnosis, drug development and disease prediction, helping doctors make more accurate medical decisions while reducing the workload of healthcare workers. In addition, financial service robots, as a new member of the financial field, are able to handle complex customer inquiries and transaction requests, greatly reducing labor costs and improving work efficiency. These examples are just the tip of the iceberg; AI technology has permeated all corners of our lives, signaling unlimited potential for future development (Xin, 2016).

At present, there are two focuses of technological breakthroughs in the field of artificial intelligence: the first is cloud robotics, and the second is human brain bionic computing technology. With the global popularization of network facilities, the rapid development of big data, cloud computing and other technologies, the continuous reduction of robot costs and the stage-by-stage realization of the goal of mass production, it will become possible for intelligent robots to obtain data through the network and process and analyze it (X. Chen et al., 2013). The

development of Artificial Intelligence presents a multifaceted technological dimension, which is widely recognized globally. From the most basic computing technology to complex cognitive models, to the development of intelligent algorithms, each link contains innovative possibilities. Currently, both theoretical research and technological applications are in a state of rapid development and change. This diverse technology system means that researchers and engineers in different fields have the opportunity to explore in depth in multiple dimensions, thus driving the entire industry forward. With the continuous emergence of technological advances and innovations, AI has demonstrated its great potential in various fields. AI is gradually becoming a powerful tool for us to solve problems, improve efficiency and create new value. In the future, with the further integration and deepening of these technologies, AI will continue to break through existing boundaries and bring unprecedented vitality and change to human society (B. Kim et al., 2018). And artificial intelligence has a multi-level technology system, from the current global trend of artificial intelligence innovation, regardless of the underlying computation, cognitive models to intelligent algorithms, the current theories and technologies at all levels are full of opportunities for innovation, the synchronization of these directions and gradual breakthroughs will continue to inject new vitality for the future development of artificial intelligence (Roy et al., 2019).

Currently, the development of artificial intelligence is causing widespread controversy around the world. Some scientists believe that artificial intelligence is a revolution in the field of science and technology, which can significantly change the level of human technology in the field of science and bring benefits to humanity (D. H. Yang, 2021). However, some other scientists hold an opposing view, believing that the rapid development of artificial intelligence technology will pose a great threat to the status of human beings on earth. With the gradual development of weak AI to strong AI, for the convenience of human beings, AI will gradually have all the thinking and action capabilities of human beings, which is a common plot in science fiction movies, i.e., robots replacing human beings to become the dominant (Zheng et al., 2021). Synthesizing these two views, both have their own rationale. The emergence of strong artificial intelligence can greatly improve the scientific and technological level of mankind, and will inevitably develop towards anthropomorphization. The side effects brought about by anthropomorphization need to be fully considered in advance. Once the fantasized event becomes reality, the disaster brought to the human race will be devastating. Regardless of the controversy, the research on artificial intelligence will never stop and the scientific process will only get faster and faster. As an alternative science and technology, AI technology needs to be perfected, but not rushed into development. Related scholars and scientists for this aspect of the

research can be said to be almost crazy, more and more advanced and safety unknown artificial intelligence equipment will be manufactured. Technically, there are still major shortcomings, so it is necessary for today's avid scientists to pay attention to the innovation of this technology (H. Y. Lin, 2024). Technically, it should look at the later safety work to ensure the human controllability of artificial intelligence. Artificial intelligence is a very important technology for the overall scientific and technological progress of mankind, which is related to the overall future direction and lifestyle of mankind. The danger of artificial intelligence to human beings should be paid attention to all over the world to ensure the interests and status of human beings, which will be of great significance to the overall security and economic construction of the world (Tong, 2016).

Artificial Intelligence, a term that symbolizes the frontier of future science and technology, crosses the boundaries of many disciplines, including, but not limited to, the sophisticated algorithms of cybernetics, the relentless pursuit of information transmission efficiency in information theory, the in-depth study of complex computation in computer science, the critical role of mathematical logic in reasoning and problem solving, and the deep understanding of human intelligence in neurophysiology. The cross-fertilization of these disciplines has not only given rise to the innovation of AI technology, but also opened up unlimited possibilities for its application in various industries (Hao, 2020).

2.2.6 Blockchain

Blockchain technology was not created by chance, but is the inevitable result of the development of Internet technology to a certain period of time (H. Y. Huang et al., 2020). Blockchain technology originally stemmed from Bitcoin (Nakamoto, 2018), It is the core supporting technology for virtual digital currencies such as Bitcoin (G. B. Li et al., 2023), The aim is to address how to build an ecosystem of "trust" to meet the needs of activities that occur and evolve in the absence of a credible centralized institution, as well as in the face of information asymmetry and uncertainty. Blockchain technology is literally a series of blocks of data connected together in an orderly and chronological chain, and can be simply referred to as a more advanced and secure shared database (Wen, 2024). Blockchain is also a decentralized distributed ledger technology that records and verifies transactions through cryptography and a distributed network to ensure data security and integrity, and its features include decentralization, immutability and transparency (M. Xu et al., 2019).

The architecture of blockchain technology is a multi-tiered ecosystem of different

components, with each tier taking on specific functions and responsibilities (P. Tan et al., 2016). The data layer is responsible for creating and maintaining a distributed ledger that records all transaction information and ensures that it cannot be tampered with. At this level, the transaction history of cryptocurrencies such as Bitcoin is preserved and verified through such mechanisms (L. Zhang et al., 2024). The network layer, on the other hand, serves as a bridge between the nodes, which communicate through a decentralized network to enable the transfer and processing of data. The role of the consensus layer is to ensure consistency between nodes by having all nodes operate under the same rules. When new transactions occur, the consensus layer validates them and adds them to the existing chain, while also resisting any malicious attempts to break the consensus. The contract layer sits at the heart of the blockchain and it supports the execution of smart contracts (Zou et al., 2019). This means that complex contracts can be constructed on the blockchain that contain legal terms, financial instruments, and other forms of digital agreements. Users can customize these contracts to suit their needs without having to rely on third-party organizations. The application layer typically refers to applications that are developed directly using or based on blockchain technology. These applications may include scenarios as diverse as copyright protection, identity verification, supply chain management, or digital financial services (Y. H. Zhang et al., 2018).

Blockchains can be categorized into public and permissioned chains based on the authority of the members to join the blockchain. The public chain is characterized by the fact that everyone has access to the blockchain and can obtain all the information of the entire blockchain or conduct decentralized transactions at any time, so the public chain is also considered to be a completely decentralized blockchain (Ferdous et al., 2021). Permission chain is characterized by the fact that all nodes participating in the blockchain are permitted and only permitted nodes can participate in the network. Permission chains are generally used in scenarios where internal information needs to be kept secret (Lai & Chuen, 2018). Permission chains are not completely decentralized, but are weakly centralized or polycentric. Permission chains can be further categorized into private and federated chains, the difference between the two being the need to determine the number and identity of nodes before the network is established. Private chains do not allow everyone to access the blockchain, but only nodes licensed by the blockchain owner or maintenance group are allowed to join the chain, with one or more nodes in the hands of each participating organization, and with the number and identity of the members determined as soon as the blockchain is up and running (Dib et al., 2018). A public chain is a completely open, decentralized blockchain network that is not restricted by specific authorizations and allows anyone to participate, view and verify transactions, guaranteeing fairness and

transparency. However, its privacy is relatively low, as all participants have access to transaction data. Public chains are widely used in digital currencies (X. Y. Wang & Zhang, 2022), smart contracts, and decentralized applications (DApps) (Hou et al., 2020), among other open uses, and their control and governance relies on network-wide consensus, usually shared by the community. A federation chain constitutes a semi-centralized blockchain network structure that is jointly governed and controlled by multiple designated entities, which usually need to be formally approved by the members of the federation in order to join that federation chain. Coalition chains exhibit a great deal of flexibility in their openness, which can be both public and restricted, and they pay particular attention to the protection of privacy, with transactions being viewed and verified only by bodies explicitly authorized by the coalition members. The core functions of a federated chain include cooperation and data sharing in various fields such as finance (Cao, 2024), management of supply chains (Ding, 2024), healthcare., while the management and control of the federation is jointly decided and maintained by its members. Private chains constitute a highly centralized blockchain network that is entirely managed and controlled by a single entity or a specific organization, and all participants must obtain the appropriate authorization to participate. This type of blockchain is usually designed to be completely closed to the public and open only to authorized users, which ensures that the privacy and security of the users are fully guaranteed. Private chains are mainly used for internal applications in enterprises, such as authentication (Fu, 2023) and privacy protection of sensitive data (Cheng, 2024), which are managed and governed entirely by an independent entity or organization and are not decentralized. The technical basis of the blockchain is a set of consensus algorithms without the participation of third-party institutions. A consensus mechanism is a rule that is recognized and followed by all participants. Blockchain-based consensus does not require to be guaranteed by a third-party institution; it is based on workload and mutual trust (X. R. Huang, 2019). Currently, there are two main types of consensus mechanisms used on blockchain: load-based and trust-based consensus. Proof of workload, authorized proof of value are load-based consistency mechanisms. Trust-based blockchains can greatly reduce the difficulty of adding blocks while sacrificing some of the decentralized nature (Feng, 2022)

From a realistic point of view, the current blockchain platform still has many deficiencies in many aspects, and is yet to be further improved and developed (Shao et al., 2018). Blockchain is widely used in various industries for its decentralization, openness and transparency, non-tampering, traceability and other characteristics. Blockchain technology brings a lot of positive effects to the future development of technology, for example, there is no need for complicated

personal identification. If these documents are lost or missing, it will cause unnecessary losses or even irreparable harm. At this stage, birth certificates, title deeds and marriage certificates may lose their legal validity during cross-country travel due to a variety of factors such as geographic location. In addition, embedding a cryptographic signature module in a smart contract can also achieve effective authentication of these documents (Y. Huang et al., 2018). The immutable property possessed by blockchain technology provides a fundamental solution to this dilemma. By notarizing the relevant documents on the blockchain and combining it with the smart contract mechanism, we can deal with the challenges posed by complex rules more effectively. The irreversible nature of the blockchain can be used to verify the authenticity of these documents, while smart contracts can be used to validate their legitimacy. Blockchain technology can be used to update these documents at any time according to the needs of the security sector, which greatly facilitates people's overseas travel. Further, combining blockchain technology with digital copyright protection (Bai, 2024). Creators can upload their original works to the blockchain platform, and after uploading them through the blockchain, users can view the relevant information about their works and gain access to their works by paying copyright taxes, not through the copyright owner, but through blockchain technology, directly into the author's account (Hogarth & Wei, 2024). With the continuous development of blockchain, the solution of these problems can not only realize the protection of digital copyrights, but also reform the transaction method of digital copyrights, the income distribution method and the payment method of users, and in the future, it can also establish an industry chain sharing platform that combines users, copyrights, producers and distributors. Second, federated blockchain has been applied in the secure storage and sharing of healthcare data (Q. Sun et al., 2023). By introducing the idea of "centralization", blockchain technology is used to build a new distributed healthcare data management model, which can effectively manage and improve the security of massive data. In the healthcare data system, each piece of data records the patient's drug usage, medical history, allergy history, lab test results and other information in detail. The highly autonomous nature of the data itself makes it difficult to centrally store these data and ensure their integrity and security (Z. Li, 2022). Based on the existing distribution of healthcare resources, healthcare organizations can be categorized into different levels. By adopting various consensus mechanisms such as PBFT, it can be ensured that medical institutions in the alliance chain can share patient health information among different hospitals within the alliance without the intervention of a centralized system, thus reducing the security risks that may be brought by the traditional centralized storage method (Z. W. Chen, 2022).

Blockchain technology is a new technology that has shown potential and value in many

fields. However, to fully realize its potential, a series of challenges still need to be addressed at the technical and application levels. Future research should focus more on improving blockchain scalability, security, and privacy protection, as well as exploring its potential application value in new fields.

2.2.7 Digital twin

The digital twin, also often referred to as digital mapping or digital mirroring, represents an advanced stage in the digitalization process. It involves highly realistic mirroring and real-time mapping of physical entities in a virtual environment, which reflects the performance of the physical entity product in question throughout its life cycle. Digital twin technology is mainly used for manufacturing by constructing three-dimensional models that are processed as virtual prototypes. With the continuous progress of information technology and manufacturing industry, it is gradually recognized that digital twin technology has a broad application potential in the manufacturing industry (J. F. Wang et al., 2023). The concept of digital twin was first introduced in 2003 by Michael Grieves, a professor at the University of Michigan (USA), describing a digital twin as an information mirror model, defined as a digital replica of a living or non-biological physical entity. The digital twin concept gained popularity as the cost of sensors and Internet of Things (IoT) systems decreased and their application became feasible, and in 2012, the National Aeronautics and Space Administration (NASA) (Tuegel et al., 2011) published a roadmap for "Modeling, Simulation, Information Technology, and Processing" to build a spacecraft identical to the airborne spacecraft. The digital twin entered the public eye when NASA (Tuegel et al., 2011) released its "Modeling, Simulation, Information Technology, and Processing" roadmap to build spacecraft projects identical to airborne spacecraft, so that the spacecraft twin could spatially reflect, simulate, and predict the operation of another spacecraft in space. Then, related organizations such as Siemens and the U.S. Department of Defense conducted in-depth research and practical applications of digital twin technology. Digital twin is a new model that integrates information into the physical world and realizes the transformation from "things" to "people". Digital twin technology has been proposed because it involves multiple disciplines, but since its introduction, there has not been a clear definition, which has led to different definitions in various fields according to their own needs and research perspectives. From the field of industrial control, digital twin refers to a completely new system formed by combining the digital and physical worlds. In 2015, the concept of digital twin is defined as a method of creating virtual models for physical entities using digitalization technology. Scholars at home and abroad also have different definitions of digital twin, F. Tao

et al. (2019) describe digital twin technology as the use of digital means to construct a multidimensional, multiregional, interdisciplinary and dynamic virtual model of physical entities with multiple physical parameters, and to provide a detailed description and simulation of the attributes and rules of the physical object; Haag and Anderl (2018) describe digital twin as a digital process that simulates the behavior of a product by means of data and models in a real environment, which provides a digital presentation of the full-cycle information of the product; According to scholars such as Cui et al., the digital twin technology is an advanced realistic simulation method that combines multiple domains and technologies, such as physical modeling, sensor information, and historical data, which responds to the physical object instantly in a virtual real-world environment , thus providing the object with responses throughout its life cycle. Cui et al. (2019) define digital twin as a technology that adds or extends new capabilities to a physical entity by means of feedback from virtual-reality interactions, data fusion and analysis, and iterative optimization of decisions. Although the definition of digital twin varies in different industries, its common feature is that digital twin integrates the physical world with the virtual world, so that the virtual entity can reflect the real world in real time by using communication technology and realize data transmission, and the twin can make corresponding adjustments according to the changes of the physical entity, and this process is real-time and two-way. Currently, the main research content of digital twin technology includes: digital modeling, sensing network construction, distributed interaction environment construction, data processing and visualization, intelligent decision-making and services. Ideally, the digital twin system can realize autonomous learning through multi-source feedback information and shared intelligence through collaborative interaction among multiple twin individuals.

Digital twin is to digitally create a virtual model of the physical entity, with the help of data to simulate the behavior of the physical entity in the real environment, and to add or expand new capabilities for the physical entity by means of virtual-real interactive feedback, data fusion analysis, and iterative optimization of decision-making. As a technology that makes full use of models, data, intelligence and integrates multiple disciplines, digital twin is oriented to the whole life cycle process of products, plays the role of a bridge and link connecting the physical world and the information world, and provides more real-time, efficient and intelligent services (F. Tao et al., 2017). Digital twin has experienced the conceptual development period, application exploration period, application pioneer period, standardization period, and comprehensive coverage period. NASA defines it as an integrated simulation of multi-physical quantities and spatial scales reflecting its existence through physical models, sensor data

updates, and other means. In the exploratory phase of application, digital twins have been rapidly developed and progressively applied in aerospace, healthcare and energy, among others (Diego et al., 2022). In the pioneering stage of application, digital twin technology was used to predict the whole life of warplane components for the first time, and subsequently, companies such as IBM, Microsoft, and Google entered this field one after another. In the standard development stage, some industries have introduced a number of industry standards, including "digital twin", including industry-oriented "digital twin" (OPC)., and a number of industry white papers have been introduced to promote the "digital twin". A number of industry white papers have been issued to facilitate the standardization process of "digital twins". Across the board, digital twins will gradually be used in brand-new fields such as Go deduction, network modeling, and 6 G devices, providing important support for the development of next-generation networks and the construction of armies.

Cyberspace modeling and simulation is both the core of transforming physical entities into digital twins and the key to realizing the application requirements of cyber digital twins (D. Y. Chen et al., 2022). However, with the continuous development of information security, the requirements for information security are getting higher and higher, and the existing means of information security protection based on information security can no longer meet the security requirements. Through this method, we are able to simulate many types of attack scenarios and test and examine new protection schemes to detect possible security problems early (Pirbhulal et al., 2022).

Digital twin technology has received a lot of attention in recent years. Digital twins were listed as one of the top 10 strategic global technology trends in 2016 and 2017 by Gartner (Gartner). In November 2017, Lockheed Martin, the world's largest weapons manufacturer, listed digital twins as one of the six cutting-edge technologies for the future defense and aerospace industry; on December 8, 2017, the Academic Alliance of Intelligent Manufacturing of the Chinese Association for Science and Technology (CAST) listed digital twins as one of the six cutting-edge technologies for the future defense and aerospace industry. On December 8, 2017, the "smart manufacturing" academic alliance of the Chinese Association for Science and Technology listed "digital twin" as one of the world's top ten scientific and technological advances. Meanwhile, some international famous enterprises have started to apply digital twin technology in product design, production and service. In terms of product design, Dassault has built a 3D experience platform based on digital twin technology, which continuously optimizes the product design model through user interaction feedback and feeds back to physical product improvement. At the manufacturing level, Siemens builds a production system model of

integrated manufacturing process based on digital twin, forms a model-based virtual enterprise and an enterprise mirror based on self-learning technology, and validates its application with Siemens industrial equipment NanoboxPC as an example (F. Tao et al., 2017).

Theory and practice, in-depth multidisciplinary exchanges, multidisciplinary intersection, and multidisciplinary crossover are the trends of the future. This is both a challenge to the existing knowledge system and a new driving force for scientific and technological progress. With the rapid development of a new generation of information technology represented by big data, cloud computing and artificial intelligence, digital twins are rapidly emerging and deeply integrating with all areas of society. The technology can generate a "virtual copy" of the entity, realize the accurate mapping and simulation of the real world, and is a powerful tool to promote the digital transformation and intelligent upgrading of enterprises (Z. Ren et al., 2024). In recent years, the concepts of "Smart Manufacturing" and "Industry 4.0" have gradually taken root in people's hearts, and "Digital Twin", as an important part of this strategy, has achieved fruitful results in related fields. As an important part of this strategy, "digital twin" has achieved fruitful results in related fields. From the perspective of smart manufacturing, the use of digital twin technology for dynamic monitoring and optimization of the production process can effectively improve product quality and efficiency. In the context of Industry 4.0, the research results of this project will help realize the transformation of traditional manufacturing to intelligent manufacturing and accelerate the process of industrial automation and informatization. With the continuous progress of science and technology and the continuous expansion of the scope of application, digital twin technology will play an increasingly large role. It will become an important force to promote China's economic and social development. Digital twin technology has an important application value in the fields of health care, urban planning, transportation. It is of great significance to improve decision-making accuracy, optimize resource allocation, and enhance system coordination and predictability. Therefore, digital twin is a research direction with great development potential both in academic research and application.

2.3 Challenges and benefits of digital transformation

All transformations are tricky, but digital transformation is evidenced to be even tougher due to the swiftness and velocity of vicissitudes in the digital domain and the consequence of digital disruption. Kossowski et al. (2020) pointed out that the realization rate of digital transformation is reliably low (i.e., under 30%) over the years of intensive research. Some authors have identified diverse lists of defies and difficulties in an effective digital transformation. These

include organization structure, business model and processes, IT infrastructure and capability, employees, software and technological complexity, high cost of technology, rapid changes in technology, and continuous change in customer needs and demand.

First, the organization structure is a primary challenge for enterprises undertaking digital transformation. The original structure may have been created to assist the subdivision's inner goals; the workflow can be supple, data in silos, communication deficiency efficacy, and room for incessant upgrading is restricted. For enterprises to support digital business, they need to alter their structures to conform to the digital age.

Second, business models and processes are another challenge that enterprises face in their quest to apply digital transformation in organizational activities. To curb this, enterprises need to alter the communication with clients and how clients are involved with products, need to alter punter experience with e.g., digitally-enabled e-commerce, and need an incremental or essential business model variation.

Third, enterprise IT infrastructure and capability may not support the digital objectives of the organization. Enterprises aiming to achieve digital success must improve their prevailing basic systems, networks, and databases to boost innovation performance.

Fourth, another critical challenge confronting organizations is employees' comprehension of digital matters. Pushback from employees centered on the dearth of comprehension of the need for alteration, digital skills gaps among present personnel (e.g., executives), and the dearth of digital talents (Boneva, 2018). From the enterprise survey, 54% of enterprises reported they cannot transform digitally, as a result of the dearth of technically skilled workforces. For enterprises to thrive in the transformation operation, a high level of digitally inclined workforce is necessary. Thus, the enterprise has to put together a high-performing, digital-savvy team to attain the best outcome.

Fifth, software and technological complexity have been noticed by scholars as another challenge in the implementation of digital transformation. The software and technology accessible to enterprises are multifaceted and can be frightening. This is a most important defy for enterprises undertaking digital transformation from the execution operation to the data amalgamation outlook. Executives should consider software and technological intricacy in the initial phases of a transformation and highlight the best-integrated structure. In addition, the high cost of technology can create a huge difficulty for enterprises implantation of digital transformation. The cost that comes with technology is very huge, as digital transformation is not inexpensive.

From the apparatuses desired to the software, the whole thing comes with a price tag.

Certain enterprises are not able to transmute digitally as they cannot manage to pay for either one or both of these, making them unable to compete with others, thus dropping their clients. Furthermore, authors have identified rapid changes in technology as another contributing factor to the challenge of digital transformation. Even though technical apparatuses come with a price tag, prevailing technologies and gears become outdated. Enterprises must adjust to those fresh vicissitudes lest they fall behind. This is a stern defy facing enterprises that have been able to alter their long-standing and labor-intensive operations to digital. Moreover, continuous change in customer needs can affect digital transformation success. Clients have ever-changing desires; enterprises have to meet them. To transmute digitally is not a relaxed undertaking that needs more or less a year to execute. For the period, a client can decide they cannot hold your fire and will leave for a new enterprise.

On the other hand, digital transformation is not a choice that most enterprises can avoid. In today's business environment, digital transformation has become a required phase for enterprise survival. From the extant literature, scholars have researched digital transformation and established the most substantial advantages that digital transformation can bring to enterprises. These include the following: First, it enhances data collection and analysis. In recent times, every enterprise has been gathering a massive quantity of data without actually getting the most out of it. However, part of digital transformation is to create a structure for collecting pertinent data and utilizing them as a foundation for enterprise acumen and enhanced policymaking. Second, it improved productivity and efficiency. The traffic jams or blockages like structures that do not interconnect with each other or manual data entrance can be rationalized or eradicated. Third, the concept can enhance the customer experience. It surges the haste with retorting to vicissitudes in demand in the market. In recent times, customers' expectations concerning rapidity, simplicity, and application, among others, are high in the digital environment. Providing digital apparatuses to the customer makes the enterprise more eye-catching and permits improved customer retention. Fourth, digital transformation enhances digital culture and improves the workforce's skill set. Digital culture cultivates the workforce's creativity, which leads to innovation and invigorates incessant learning, impetus, and agility. Experienced workforces are also more tolerant of transformation. Fifth, digital transformation increased agility. Thus, an agile organization can straightforwardly espouse incessant upgrading schemes; amplified agility permits better alteration and immense disruption adaptations and agrees to keep up with the rivalry. Moreover, digital transformation upsurges profitability. Results of more effectual and agile processes, with better policymaking and better-quality customer experience, mean enlarged returns and greater cost-effectiveness (Rossi et al.,

2020).

2.4 Firm growth performance

2.4.1 Concepts of firm growth performance

The term performance is extensively applied as the dependent variable in any scholarship, pointing to organizations that pursue to establish an enhancement brought about by a specific innovation or intervention. There are diverse categories of performance in the extant works. These consist of financial, environmental, operational, and innovation performances.

Richard et al. (2009) assert that the assessment of an enterprise's organizational performance is centered on the investigation of the enterprise's aim or purposes and comparison with three specific conclusions: financial performance (measured by probing profits, return on assets, return on investment (ROI), among others); product market performance (measured by probing sales and market share of the product or range of products); and shareholder return (measured by probing the economic value-added, total shareholder returns, among others). Corbett and Van Wassenhove's (1993) model reflects three measurements of performance, cost or efficiency, quality, and time, respectively.

These are more germane and provide a measure that can be used in various settings. Dyer and Reeves (1995) scrutinized a range of dimensions that encompassed results such as employee turnover, absenteeism, and job satisfaction but also looked at broad-spectrum staff productivity. These are more pertinent, but it could be contended that they are not direct measures of organizational performance. In the case of the concept, the issue of how to measure operational performance in an enterprise is a subject that frequently shows up in extant literature (Hesketh & Fleetwood, 2006). Venkatraman and Ramanujam (1986) offered the most commonly applied classifications of operational performance. In the study of the relationship between corporate strategic change and corporate performance, foreign scholars have not yet reached a unanimous conclusion: Nahata (2007) believe that conducting strategic change is conducive to the improvement of corporate performance and the probability of survival, and that innovations bring competitive advantages to enterprises and help them to obtain revenue growth and profit improvement; while E. Kim and Mc Intosh (1996) found that conducting strategic change may reduce corporate financial performance and the probability of survival instead of increasing or decreasing it. Intosh found that making strategic changes reduces firms' financial performance and probability of survival. Hambrick and Schecter (1983) found that the

relationship between firms' strategic changes and performance is not just between improvement and reduction, but depends on the type of strategic change and the nature of the environment. Different innovation strategies produce different levels of firm performance, which means that not all innovation strategies enhance firm performance and produce positive impact effects under the conditions of a given environment (Hausman et al., 1984). They espoused a strategic management viewpoint and accentuated and prejudiced the measurement in the direction of profitability or effectiveness and productivity or efficiency and penciled a strong dissimilarity between financial and operational performance.

However, the scholarship on organizational performance is still abstruse and comprises a set of 'loose constructs' (Rogers & Wright, 1998). Thus, there is no clear definition of absolute measures of performance. To comprehend the association between digital transformation and firm growth performance, there is a need to review measures of firm performance that are used in digital transformation research. Hence, there is an enthralling need to scrutinize the conceptual definition of performance and how performance could be measured either through objective or subjective gauges (Boadu et al., 2018). The former approach is adopted to obtain performance indicators from companies (secondary data), while the latter approach is espoused to ask respondents to evaluate performance compared to the performance of industry players.

The mechanisms comprising Firm growth performance, which are well-thought-out and predominantly applicable in this inquiry, are as follows: “Effectiveness” (enterprise meeting its aims); *“*efficiency*”* (enterprise applying the smallest probable resources to meet its aims); *“*financial*”* (enterprise enhancing its financial capacity to meet financial objectives). The researcher contends that enhancing the growth performance of an organization is indispensable to its survival in today’s competitive market arena. Explicitly, in the context of high-tech industries, it is therefore imperative to scrutinize prudently the outcomes that a digital transformation pursues to attain and then determine whether there are apposite gauges that can completely point toward an enhancement in performance (Shrestha & Chalidabhongse, 2006).

2.4.2 Digital transformation and firm performance

Digital transformation continues to alter both consumer-oriented (Hagberg et al., 2016; Kraus et al., 2022; Nasiri et al., 2020) and manufacturing (X. Wang et al., 2017) industries and businesses across the globe. Compared with the traditional function of information technology, digital transformation has a much more robust influence on enterprise operational activities in terms of both scope and intensity. Björkdahl (2020) asserts that enterprises’ digital transformation emphasizes enhancing the operative procedures in focal corporate activities.

Thus, digital transformation enhances corporate processes by plummeting transaction costs, upsurging employee productivity, enhancing asset effectiveness, and boosting the supply chain. Various studies have established the relevance of digital transformation in the inspiring performance of enterprises (Morakanyane et al., 2017; Xie et al., 2022). Other literature reviews on digital transformation and performance among researchers are obvious (Cenamor et al., 2019; Ghezzi & Cavallo, 2020; Libert et al., 2016; Ziyadin et al., 2019).

For example, scholars like Libert et al. (2016) and Ziyadin et al. (2019) have established a positive relationship between digital transformation and firm performance. Cenamor et al. (2019) established the paramount role of digital transformation in resolving the technology challenges of large corporations through the dissemination and sharing of digital technologies. Thus, digital transformation describes the process of utilizing digital technologies to trigger significant changes to companies' value creation paths (Vial, 2021). Vial (2021) also recognized the important role of digital transformation in triggering significant changes to companies' value creation paths. He encouraged organizational support rather than control to enhance companies' value creation. Digital technology is a vital component in the management of creative performance. Digital technologies such as social platforms (Bharadwaj et al., 2013), networking sites (Chege et al., 2020), and the Internet of Things (Ceipek et al., 2021), artificial intelligence, biotech, nanotech, robotics, cloud computing, and the machine learning (Carayannis & Campbell, 2021; Carayannis & Morawska-Jancelewicz, 2022) can signifies collective values (Savastano et al., 2019), leading to innovation performance to address customers concerns, which, in turn, enhance sustainable competitive advantage (Chege et al., 2020; Hanna, 2016; Neumeier et al., 2017; Savastano et al., 2019). Srivastava and Shainesh (2015) established that digital technologies such as teleophthalmology permit hospitals in India to increase access to care while plunging patients and facility costs. These technologies aid healthcare facilities in improving the efficacy of communiqué between subdivisions; they also aid in procedures to get rid of superfluous links. Thus, digital transformation condenses the transaction costs in the enterprise's production procedures. Mukti et al. (2021) investigated the linkage between digital equipment and rural farmers' productivity. The result demonstrates a positive linkage, which is statistically significant. Thus, digital transformation aids improve labor productivity. However, other researchers have a conflicting opinion vis-à-vis the direct link among the variables in an enterprise. They consider that enterprises can boost growth performance via a mediator or moderator outcomes influenced by digital transformation (Boadu et al., 2021).

Digital transformation is not only a technological enhancement, but also an all-

encompassing change in firm structure (Hanelt et al., 2020). There are various research findings on the mechanism of digital technological change on the growth performance of firms. Some studies have shown that the transformation of a company through the process of computerization can improve its competitiveness and its position in the industry. For example, by using digital tools and management systems, a company can improve productivity and customer satisfaction, which in turn increases revenue and market share. At the same time, digital technology has also become an important way to enhance a company's ability to withstand risks, helping it to cope with the complex and volatile market environment and achieve steady growth. At the same time, digital technology changes have both direct and indirect impacts on a company's financial performance. For example, by investing in digital technology, the productivity and product quality of manufacturing enterprises are improved, thus enhancing their business performance. On this basis, this thesis proposes a concept based on the "financial indicator system", i.e. "financial indicator system".

2.5 Cross-border search capability

Cross-border search is the act of firms crossing existing organizational and technological boundaries to identify and access heterogeneous resources (Rosenkopf & Nerkar, 2001). According to existing research, cross-boundary search has different focuses, and scholars have categorized its dimensions from multiple perspectives, mainly covering distance (where) (Asheim & Isaksen, 2002), way (how) (Rosenkopf & Nerkar, 2001), content (what) (W. H. Zhang et al., 2014), time (when) (Feng, 2022) and other dimensions, to study how these dimensions can improve the organization's KM efficiency and promote organizational innovation. However, due to changes in the external competitive environment, it is difficult for companies to conduct knowledge search in an optimal way, and they usually can only choose a more reasonable search strategy based on their existing resources and capabilities, combined with the development goals of the organization. Different cross-border search objectives may lead to the acquisition of different types of knowledge and the way they are utilized, resulting in different performance impacts (M. M. Yang & Wang, 2020). Current research has analyzed the concepts, characteristics, and dimensions of cross-border search based on the knowledge base view and organizational search theory, and has drawn some valuable conclusions. However, there are still some shortcomings. First, existing studies have divergent conceptual definitions of cross-border search, involving related concepts such as remote search, external knowledge search and international search. Second, the existing literature mainly divides the

dimensions of cross-border search based on geographic and technological boundaries, ignoring the intrinsic attributes of knowledge and the subjective initiative of organizations in knowledge search behavior. Further, operationalized definitions and measurements of knowledge search are mainly based on the distance of knowledge search, lacking an effective integrated measurement model to comprehensively and accurately measure cross-border search. Finally, there is little existing literature that deals with the micro-process of organizational knowledge search and its underlying logic, which lacks effective learnability for enterprise-specific knowledge search model selection and practical operation (S. Hu & Yu, 2017).

Enterprises' ability to gather information through narrow and multi-task procedures takes along prospects to obtain and engross varied capabilities for operative activities. Indeed, no enterprise has all the possessions and capabilities it desires, as a result, the cross-border search capability is a strategic element for enterprises to obtain capabilities from the outer environment to sustain a competitive edge (Gao et al., 2021). Thus, through cross-border search capability, enterprises can get access to exterior resources (e.g., technical capabilities) to boost prevailing resources to create value. The concept is vibrant for enterprises to hinge on to create and capture worth. For instance, in a dynamic environment, enterprises with strong technical capabilities are connected with superior innovation outcomes (Tortoriello, 2015) to create value. In addition, in academic research, we have found that foreign subsidiaries often owe their excellence to their deep understanding and mastery of the local market. These subsidiaries have deep insights into the local market environment, and their business strategies, values, and the norms they follow are carefully customized to fit the local culture and business practices (Boadu et al., 2021; Xie et al., 2022). As mentioned earlier, the headquarters of MNEs not only rely on the external knowledge of their subsidiaries, but also rely heavily on this cross-border tacit knowledge, i.e., their deep understanding of the local markets they serve, including aspects of the market's exclusionary behaviors, its unique characteristics, and the reasons for its formation. This thirst for knowledge contributes to the development of firms' capacity to innovate, as tacit knowledge provides a different perspective from traditional explicit knowledge, which enables firms to fundamentally understand and adapt to the markets they serve (Boadu et al., 2021). Many studies now recognize this type of knowledge as the key to understanding incipient market issues, generating new ideas, and solving complex problems (Xie et al., 2022). This thesis further explores the fact that as tacit knowledge accumulates, it becomes more difficult to replicate and acquire; at the same time, the growth of such knowledge can be the spark that ignites the engine of innovation, especially as it relates to market prospects or incipient challenges. In this era of deepening globalization, the transfer of highly tacit knowledge has

become critical in driving companies to develop new ideas, jump-start existing patterns of activity, and explore new opportunities. Effective integration of highly confidential tacit knowledge decisions is therefore critical to stimulate innovation. This integration is not just technical, but a strategic level of understanding that allows organizations to offer unique and irreplaceable services or products to their customers in a unique way. Through such knowledge management, companies can stay ahead of the curve and achieve sustainable growth in a highly competitive local market (Xie et al., 2022).

Therefore, the study argues that integrating external and internal resources can contribute to organizational growth, competitiveness, and survival. Previous studies have established a significant relationship between cross-border search capability and enterprises' performance outcomes in the extant works (Rosenkopf & Nerkar, 2001). Other scholarships find a positive effect of boundary-spanning on innovation and performance (Z. Ren et al., 2018; Rosenkopf & Nerkar, 2001; Ze et al., 2018). Consequently, it becomes evident that the relationship between digital transformation and firm growth performance can be mediated by cross-border search capability, and investigating these relationships in a different cultural setting in the Chinese context is meaningful.

2.6 Managers' digital concern

The role of top executives in the organizational setup cannot be over-emphasized. Extant literature has given various accounts of the duties and responsibilities of top executives in shaping organizational activities toward growth, competitiveness, and sustainability. The current study contends that the role of top executives as a driver for synthesizing novel corporate strategies needs specific competencies development. Thus, top executives need skills to manage and develop their corporate performance. The concept of skills remains relevant in today's market environment, which is full of uncertainty and volatility due to technological, economic, environmental, and competitive factors (Boadu et al., 2018). Authors have established a complementarity between technology and high-skilled labor or skill-biased high-tech alteration (Daron et al., 2011). Generally, the term skills' has been applied to describe individual characteristics. Nevertheless, the work of (Sousa, 2018), expanded the scope of skills, which makes it multifaceted, and its comprehension and concept mark out problematic. Boadu et al. (2018) describe skills as a resource – of individual and organizational nature – that pathway for keenness, growth, and efficiency advantages to enterprises. Academics have acknowledged the concept of skills and its development in many research works (e.g.,

(Heckman & Kautz, 2012)). Indeed, they see skills development as a strategic weapon to muddle through the contemporary market environs, predominantly as the market has altered from a mass-production market to a customization market where superiority, worth, and rapidity of distribution are tense. This alteration has fetched novel settings in which lots of enterprises tussle to muddle through: fresh and evolving client segments, cultural multiplicity in an international market arena, market instability, high client anticipations vis-à-vis superiority of products/services, and the influence of the internet on an enterprise's primary business (Akerman et al., 2015; Green et al., 2016).

In this context, the present research argues that the complication and the hesitation, comparatively in line with the globalization and faster tempo of technological alteration, call for executives with skills that aid the enterprises to overcome the seeming tasks (De Vasconcelos et al., 2017). For instance, managers' digital concern which is described as the managers' commitment level and mental models for the organization's digital matters is an essential contributing factor to corporate growth performance (Adner & Helfat, 2003). Thus, managers with skills in digital issues could identify and implement solutions that improve digital performance, digital competence, and customer satisfaction; and uphold the enterprise ahead of the innovation curve. Digitally savvy managers are already supporting their workforce, procedures, and values to attain their enterprises' long-term digital triumph.

2.7 Organizational agility

2.7.1 Definitions of organizational agility

In the twenty-first century, the global economy faced substantial vicissitudes in every facet, particularly excessive vicissitudes in the communicational networks. Thus, in today's volatile competitive global economy, enterprises must have diverse competitive aspects to contest; else, they will change in the direction of obliteration. One of these competitive aspects that enterprises require in today's blustery environments is agility. The originators of the concept "agility" at the Iacocca Institute of Lehigh University (USA) described it as an industrial scheme with competencies or know-how (hard and soft know-how, human resources, cultivated executive, and gen) to bump into the speedily ever-changing desires of the market environment (rapidity, suppleness, clienteles, rivals, providers, structure, reaction). The concept is an effective implementation of competitive foundations (e.g., rapidity, suppleness, novelty, and quality) via the incorporation of reconfigurable resources to create customer-driven goods and

services to enhance enterprise performance (Yusuf et al., 1999). Agility offers the enterprise the opportunity of rapid retort and compatibility with environs and permits the enterprise to upsurge its effectiveness (Yeganegi & Azar, 2012). Agility accentuates rapidity and suppleness as the most important features of an agile business (Gunasekaran, 1999). A likewise vital characteristic of agility is an active retort to alteration and doubt (Goldman et al., 1995). Agility talks about the active reactions to vicissitudes (Bessant et al., 2001). Agility discusses the application of vicissitudes as in-built prospects in a blustery environment (Sharifi & Zhang, 2001). Agility describes the ability to endure in a changeable environment (Dove, 2002).

Incessant alteration is progressively the fresh norm rather than the exemption in modern organizations (Eisenhardt & Brown, 1998). These vicissitudes call for organizations to reread their strategic precedence and visions (Sharifi & Zhang, 2001; Sharifi & Zhang, 1999). Organizational agility is one of the ways and means for retorting to these vicissitudes and insurgency issues. As a result, attention to organizational agility has developed exponentially for academics and practitioners (Tallon & Pinsonneault, 2011). Thus, the importance of organizational agility has been stressed in the management literature over the past decades, but there is still a great hesitation concerning research on agility. A survey conducted by McKinsey & Company reveals that nine out of ten executives rated organizational agility as both crucial to enterprise triumph and intensifying in significance over time (Sull, 2009).

Certainly, organizational agility has become the new paradigm that drives competitive businesses forward. It plays a critical role in the day-to-day operations and strategic development of organizations. The core value of organizational agility is that it provides employees with the necessary knowledge base that is not only broad but also deep, enabling them to acquire extraordinary expertise (T. Li, 2023). In addition, organizational agility facilitates changes and structures that enable firms to quickly adapt to market changes and customer needs. Through flexible organizational structures and processes, firms are able to implement change more effectively and thus maintain a competitive advantage. At the same time, organizational agility encourages the adoption and application of new technologies, which not only improves efficiency, but also opens up opportunities for innovation. Organizational agility is a key factor for modern enterprises to stay ahead in the competitive marketplace (Sherehiy et al., 2007).

However, in recent years, academics and practitioners have delved into the concept for better comprehension. There are numerous definitions of organizational agility, which have created a paradox in the literature (Felipe et al., 2017; Nafei, 2016; Sherehiy et al., 2007; Teece et al., 2016; Yeganegi & Azar, 2012; Yusuf et al., 1999). However, these definitions often

center around conveying the idea of promptness and the altering market environment. It is derived from the performance features of an agile enterprise and is engrained in two interrelated notions- “enterprise adaptability” and “enterprise flexibility.” Thus, organizational agility can be observed as the state of organizational performance in terms of suppleness and malleability and is achievable via enterprise undertakings. Enterprise adaptability emphasizes how an enterprise’s system, configuration, and degree of formalization impact its capability to rapidly adjust to its environment (Sherehiy et al., 2007), while enterprise flexibility epitomizes an enterprise’s ability to modify its inner configurations and procedures in a preset reaction to vicissitudes in the environment. Thus, adaptability brings about the fit of enterprise processes to its environment, while flexibility accentuates the eagerness of enterprise resources and the simplicity of resource armament.

In precise, from the viewpoint of process-based, organizational agility is a set of procedures that permit an enterprise to detect vicissitudes and retort competently and successfully inappropriate and profitable ways in the inner and outer environments. Indeed, organizational agility is the enterprise's ability to sensor reaction efficaciously to the prospects and intimidations in the market in an appropriate mode (Overby et al., 2006). It is a preemptive management approach to uphold the enterprise’s resources and accomplish the needs of the clientele (Hitt et al., 2007).

Generally speaking, the concept describes a reaction to the difficulties posed by a market environment subjugated by alteration and suspicions. The concept encompasses a novel approach to doing business. It reflects a novel mindset on synthesizing, vending, and purchasing, and openness to novel procedures of profitable dealings and fresh measures for evaluating the outcome of enterprises and workforces. From the perspective of Kodish et al. (1995), organizational agility necessitates an enterprise to be speedy in pulling together its know-how, workforce, and executive with communiqué infrastructure in retorting to shifting client demands in a market environment of incessant and unforeseen variation. Thus, an enterprise can synthesize the requisite information for executive policymaking in a blustery environment. Mathiassen and Pries-Heje (2006) describe organizational agility as an enterprise's ability to flourish via detecting and retorting to environmental vicissitudes, which have become censoriously significant currently when the business environment is getting extremely competitive and blustery.

Thus, they regard the concept as a vital element and a probable enabler of an enterprise’s competitiveness. According to Ardichvili et al. (2003), organizational agility permits an enterprise to perform a sequence of clear-cut responsibilities efficaciously, in addition to

managing the prospects and perils in the organizational undertakings successfully. Sambamurthy et al. (2003) posit that organizational agility makes enterprises more quick to respond to market trends and more rapidly in terms of the distribution of products and services compared to non-agile enterprises. C. W. L. Hill et al. (2020) describe organizational agility as a procedure of making ready and eliminating business divisions, marketplaces, and industries to re-focus on discerned essential competencies. David (2011) asserts that organizational agility is a bundle of notions that aims at incessant enhancement, flat organizational structures, teamwork, preventing excess or damage, effectual application of resources, and handling the sequence of planning. For example, Japanese enterprises have espoused the notion of organizational agility in terms of plummeting costs via the elimination of excess.

Organizational agility encompasses three foundation dimensions sensor agility, decision-making, and agility practice and implementation (Sambamurthy et al., 2003). The concept is not only "flexible" to accommodate foreseeable vicissitudes but also can react and acclimatize to volatile vicissitudes rapidly and competently. Hence, the current thesis describes organizational agility as an enterprise's capability to attain its aims via the growth of its products, upsurging knowledge of its human resources, carrying out the enterprise's progress, and reducing its movement in a speedily mutable environment. The definitions of agility and organizational agility by different scholars are shown in Table 2.2.

Table 2.2 Definitions of agility and organizational agility

Definition	Representative Study
"Agility is the ability to retort to changeable vicissitudes with rapid reaction and effectiveness"	Erande and Verma (2008)
"Agility is an enterprise ability to respond swiftly and successfully to an environment which can adjust drastically"	Nafei (2016)
"Agility refers to the competences required to attain light movement in the enterprise"	Sherehiy et al. (2007)
"Agility describes the rapidity and speedy retort of a harmonious collection to the vicissitudes made via the environment surrounding them to attain an objective"	Yeganegi and Azar (2012)
"Organizational agility is an enterprise's capability to retort speedily and effectually to unpredicted prospects, in addition to providing, in advance, explanations that bump into probable desires"	Felipe et al. (2017)
"Organizational agility is the capability to endure and develop in an unpredicted competitive environment of continuous alteration via speedy retort to mutable markets and via meeting the needs and necessities of clienteles"	Gunasekaran (1999)
"Organizational agility is an effective implementation of the rivalry guidelines, such as rapidity, suppleness, modernization and quality, via incorporation of resources and the rearrangement of greatest performances in the environment of practical information, thru the setting up of services or products that bump into clients' penchants in light of a speedily altering environment"	Yusuf et al. (1999)

"Organizational agility is the enterprise's capability to work contentedly in a rapidly and reliably ever-changing and bitty international market environment, via creating great value and active performance"	Teece et al. (2016)

2.7.2 Dimensions of organizational agility

Scholars have identified three basic dimensions of organizational agility in the extant works. These comprise sensing agility, decision-making agility, and acting agility (Pavlou & El Sawy, 2010). First, Pavlou and El Sawy (2010) describe sensing agility as an enterprise's ability to scrutinize and monitor actions and vicissitudes in the close environment (client penchants alterations, rivalry movement, and novel knowhow) in an appropriate way (Pavlou & El Sawy, 2010). It is a tactical checking of environmental actions that could influence the enterprise line of attack, competitive exertion, and pending outcome, comprising numerous undertakings such as access to gen connected to the actions that display environmental alteration. Second, decision-making agility is an enterprise's capability to gather, mount up, reorganize and assess pertinent gen according to a diversity of origin to explicate the insinuations of the business devoid of postponement and to detect prospects and intimidations grounded on the clarification of actions, besides the growth of action strategies, which direct the reconfiguration of resources and the improvement of novel competitive actions. The policymaking work comprises numerous interconnected actions, which elucidate a lot of actions and recognize prospects and intimidations in the close environment.

Thus, it emphasizes gathering facts from manifold and varied origins to comprehend the inferences of their exertion (Thomas et al., 1993). It pursues to capture the greatest prospects of the existence of an enterprise. Third, scholars like Dutton and Duncan (1987) and Thomas et al. (1993) describe acting agility as an enterprise's ability to alter its operational activities via numerous actions and resources and reshape the enterprise's organizational configuration. It comprises a series of actions for reconvening enterprises' resources and altering enterprises' procedures on the foundation of the tenets of work ensuing from the policymaking action to tackle the alteration that emerges in the close environment (Eisenhardt & Martin, 2000).

2.8 Knowledge transfer and knowledge transfer dimensions

The concept of knowledge transfer originated in Shannon (1949) mathematical-theoretical study of the field of communication. However, since the introduction of the term into the knowledge management (Esther et al., 2019; Govind & Küttim, 2017; Paulin & Suneson, 2012) literature scholars have time and time again related it to the related term knowledge sharing

(Oliveira et al., 2019), knowledge exchange (McTiernan et al., 2019), and knowledge acquisition (Esther et al., 2019; Wijk et al., 2008) and other terms are used synonymously. The use of knowledge transfer and knowledge sharing has been elucidated in the literature (Duvivier et al., 2019; Foss & Pedersen, 2019; Goswami & Agrawal, 2020; Paulin & Suneson, 2012). These studies tend to assume that knowledge transfer emphasizes the business unit or the firm as a whole, while knowledge sharing emphasizes the individual. The process of knowledge transfer often occurs as an act of knowledge sharing driven by motivational factors by the transferring subject based on the real conditions of the transfer.

Scholars in the field of knowledge management have many definitions of knowledge transfer in existing work. Knowledge transfer is the process whereby a firm advocates the transfer of knowledge to other units or firms through some channel (Gaur et al., 2019). Knowledge transfer is defined as the process of communication between the transferor and the transferee through a transmission network, where knowledge is passed from the sending unit or firm to the receiving unit or firm for final use in a series of all-encompassing actions. Over the years, scholars in economics Arrow (1969), sociology (Rogers, 1962), have applied this concept to various fields, contributing to its development and growth in strategic management. These authors have recognized knowledge transfer as a dynamic mechanism of strategic cooperation for disseminating knowledge within and between firms. For example, through collaboration between two entities or units, knowledge resources can be utilized to create competitive advantage. Indeed, in today's competitive environment, knowledge transfer has emerged as an essential way for firms to transform their operations by providing a wide range of knowledge and expertise.

However, from the extant works, in the middle of the 20th century, Polanyi (1966) in his study of human knowledge, he categorized knowledge into two ranges, namely tacit knowledge and explicit knowledge. Tacit knowledge (also known as intended knowledge) and explicit knowledge (also known as verbal knowledge.).

2.8.1 Tacit knowledge

First, he describes tacit knowledge as ineffable, innate, embedded and context-specific. He further argues that this concept can be learned through collaboration or different experiences, and is therefore difficult to articulate and formalize with its embeddedness in individual or shared holdings and presence in top management systems, cultures and practices. He put forward the "tacit knowledge" view to broaden the perspective of knowledge transfer research, has become a mainstream research field of micro knowledge management, the competitive

advantage of enterprises from the heterogeneous knowledge, a large number of knowledge resources within the organization and the knowledge of the minds of the employees, an enterprise wants to have excellent knowledge assets not only to absorb a large number of knowledge-based employees, but also to be able to knowledge-based employees to carry out knowledge management and development, so that their individual knowledge can be quickly and effectively migrate within the enterprise, so that their individual knowledge can be shared by other employees and transformed to the organization to maximize the utility of knowledge assets. Knowledge management and development, so that their individual knowledge can be quickly and effectively migrated within the enterprise, so that their individual knowledge can be shared by other employees and transformed to the organization, to achieve the maximization of the utility of knowledge assets, while the enterprise is also able to disseminate through the project team and other forms of dissemination of knowledge to the participants to achieve the dissemination of knowledge formalization (Dixon, 2017), on the other hand, illustrates the significance of tacit knowledge, i.e. intra-organizational knowledge, for organizational knowledge transfer from both the internal and external aspects of organizational knowledge. Regarding the transfer of knowledge from outside the organization, Dixon suggests that despite its significance in the organization, this type of information is available in other organizations. For each organization, due to its unique organizational environment (comext), only the organization's internal core knowledge or skills (know-how) has its uniqueness and uniqueness, and at the same time, it is also the core element of an organization to maintain its competitiveness, because the unique skills possessed within the organization are difficult to be copied for other enterprises. A great deal of empirical evidence also proves that a company that is able to effectively transfer knowledge within the organization is more productive and viable than other institutions. Within an organization, the transfer of tacit knowledge must rely on specific tools and pathways. Inkpen (2000) examined knowledge transfer tools and classified them into three categories based on their degree of strategicity: firstly, knowledge-sharing agreements, such as joint technical meetings, regular job interviews, technical training, outsourcing of production or product design, loan of equipment, short-term loan of engineers.; secondly, interpersonal activities, such as the rotation of staff between joint ventures and the parent company; and finally, the strategic linkages, i.e., closer managerial or structural ties through joint development strategies, or long-term relationships with suppliers of equipment, parts and raw materials, as well as product design firms, consulting firms. Almeida and Kogut (1999), on the other hand, categorize the transfer tools into three categories based on the tacit nature of knowledge: interpersonal communication, coded dissemination and embedded

transfer. Tacit knowledge is something that is stored in an individual's mind and can be clearly expressed through language, words, graphics, or symbols, but it cannot be communicated in a formalized way because it is difficult for both the owner and the user of the tacit knowledge to represent it clearly. Tacit knowledge, on the other hand, can be transmitted, but it just requires a more specific method, such as a mentor or apprentice. In addition, the acquisition of tacit knowledge may come from a flash of insight or from a long period of experience and accumulation, so tacit knowledge has a certain degree of randomness and stochasticity, and most of the time it comes instantly, and it is difficult to acquire it through daily work. The acquisition of tacit knowledge is related to the working environment, working atmosphere, personal working habits, personal cultural cultivation, and personal thinking ability. Secondly, in the fragmented innovation of content, the acquisition of tacit knowledge will be presented in a fragmented state, and these aggregated and fragmented tacit knowledge can enable innovative enterprises to continuously draw more vitality, and thus accumulate, thus laying a solid foundation for the smooth implementation of the whole subject. The final completion of an innovative project depends more on the integration of a large amount of fragmented tacit knowledge, and enterprises should pay attention to the accumulation of fragmented tacit knowledge (D. Wu, 2017). Domestic scholars have studied the tacit knowledge transfer modes of multinational corporations (Xue & Guan, 2006), and summarized that the knowledge transfer modes of multinational corporations mainly include the forms of information exchange, management communication, technology transfer, personnel training, and strategic cooperation within the enterprise network. These modes of knowledge transfer promote intra-firm knowledge transfer and are considered key for MNCs to gain economies of scale and scope, capitalize on country-specific differences, and enhance their global competitive advantages. Therefore, the selection of appropriate knowledge transfer methods is of crucial importance for the efficiency and effectiveness of tacit knowledge transfer between teams (Z. Sun, 2008). Over the years, other scholars have applied and confirmed this concept of tacit knowledge as an important resource that provides a competitive advantage in most organizations. They argue that tacit knowledge provides a competitive advantage to organizations that possess critical success factors such as technical skills and specialized knowledge.

Due to the difficult-to-acquire and hidden nature of tacit knowledge, it is both a good competitiveness factor and an important factor that is difficult to be copied and replicated by other organizations or individuals. Numerous empirical studies have shown that organizations will become more dynamic if they can share tacit knowledge efficiently. Tacit knowledge sharing refers to improving the competitiveness of an enterprise by promoting potential tacit

knowledge that creates greater benefits to the enterprise. TK sharing is an important part of enterprise culture building. At the individual level, there has been a need for tacit knowledge sharing within the enterprise. In China, due to the rapid development of our economy, the quality of our labor force has been improving. Especially in certain modern enterprises, there is no longer a distinction between purely physical and intellectual labor. Workers are engaged in a complex intellectual activity that also involves highly skilled manipulation of skills. For example, laboratory workers, researchers, artists, medical workers, computer installers and maintainers, craftsmen, engineering designers and managers., usually have to possess certain experience and skills in order to efficiently deal with problems that may arise in their work, and thus to transform and innovate knowledge. Thus, tacit knowledge exchange and sharing is also an important way for teachers to develop themselves (M. H. Xu & Shi, 2024).

Tacit knowledge plays a crucial role in enterprises. Globally, Germany was the first country to take "Industry 4.0" as an important direction for industrial development, and has further promoted "Made in China 2025" on this basis. Our country is accelerating industrial transformation and development, and has made great progress. The implementation of "Made in China 2025" is not only the requirement of national economic development, but also the strategic requirement of the state and the country. The higher the demand for talents, the higher the level of selection of talents, and the greater the demand for professional skills and creativity. Since technical problems are characterized by suddenness, integration and unpredictability, they require a high level of decision-making and rich practical work experience, as well as high efficiency in solving. In this process, "experience", "wisdom", "intuition", "inspiration" which are the potential knowledge that play a crucial role in providing innovative solutions for individuals or teams (D. Wang, 2018).

Currently, tacit knowledge sharing has attracted great attention from theoretical circles and relevant departments. In August 2009, the National Institute of Standardization (NIS) officially released a national standard on the concept and architecture model of knowledge management. The introduction of this standard not only treats knowledge as an important strategic resource, but also emphasizes the impact of tacit knowledge sharing on the sustainable development of organizations and the improvement of employee quality and work efficiency. Therefore, tacit knowledge, as a core element of enterprise competitive advantage, has been widely recognized and highly concerned by all walks of life (Hui, 2011).

Tacit knowledge and its consequences for the explicitness of knowledge transfer have been widely considered by researchers. Existing findings suggest that contextual variables such as knowledge transfer dimensions can play an integral role in contributing to a firm's innovation

performance. However, there is a paucity of current empirical research on the moderating role of knowledge transfer dimensions on the interaction between cross-border search capabilities and firm growth performance.

2.8.2 Explicit knowledge

Polanyi (1966) defines explicit knowledge as knowledge formalized and codified in the form of instruction manuals, documents and norms. Explicit knowledge transfer refers to the process of disseminating knowledge that can be clearly expressed and documented as a perceptible form of knowledge that can be easily understood in its context by individuals in prescribed and organized language. Examples of explicit knowledge include recognized efforts, measures and guidelines. This type of knowledge is usually impersonal and can be encoded, stored and transmitted, making it easier to share and learn between organizations and individuals. Explicit knowledge, compared to tacit knowledge, tends to have normative descriptions, systematic presentations, is clear, stable and reproducible, and is usually formatted or coded to be structured and described through laws, regulations, theorems, formulas. According to Ellis (2004), episodic knowledge is knowledge that can be acquired through learning, that can be verbalized, and that people, in the process of using the knowledge process, can consciously realize that they are using episodic knowledge (Ellis, 2004). For example, in normal times, we can intuitively determine whether a sentence is grammatically correct or not, and if we know exactly what is wrong with the grammar of the sentence, then we are using explicit knowledge. In order, the starting age affects the learning of knowledge to a certain extent, while age does not have any effect on the learning of explicit knowledge, because explicit knowledge can be expressed and transmitted through language and words (Y. P. Song, 2024).

We can explore the characteristics, influencing factors, and implementation strategies of explicit knowledge transfer from several perspectives. Information technology (IT) tools play an important role in explicit knowledge transfer. Research has shown that the functional attributes of IT tools, such as the feedback function, the symbolic diversity function, and the multiple participant function, have a significant impact on the effectiveness of explicit knowledge transfer (J. J. Guo & Yu, 2008). These functions enhance the effectiveness of knowledge transfer by facilitating interaction and collaboration among communication partners. In addition, the familiarity of communication partners and familiarity with the topic of communication also positively moderated the relationship between IT tool functions and the effect of explicit knowledge transfer. Scholars have widely recognized this knowledge transfer as an important contributor to firm growth performance. However, the former (i.e., tacit

knowledge) differs from the latter (i.e., explicit knowledge) in that the former has the potential to create excessive benefits for the firm because it is more difficult to replicate.

To summarize, explicit knowledge and tacit knowledge are two types of knowledge of different natures, which are manifested in the following ways: firstly, in terms of quantity, Polanyi, a famous British physical chemist and philosopher, once said: "Know much, know little". This proposition firstly divides knowledge into that which is known to be able to tell (explicit knowledge) and that which is known but difficult to tell (tacit knowledge); secondly, it emphasizes that the amount of tacit knowledge is much greater than that of explicit knowledge. If we regard human knowledge as an iceberg in the ocean, explicit knowledge only reveals the tip of the iceberg, while tacit knowledge is the main body of the iceberg. Secondly, in form, explicit knowledge is a body of knowledge that can be encoded and symbolized. Mr. Shi Zhongying pointed out that "Knowledge is the crystallization of human knowledge and the subject's correct reflection of objective things." "Knowledge is a system of experience which is expressed by some kind of linguistic symbols or logical forms." Tacit knowledge is the crystallization of human non-verbal intellectual activity, which is difficult to be structured by language, words or symbols, and difficult to be explained and argued by logic. Thirdly, from the point of view of the characteristics of use, epiphenomenal knowledge is a kind of knowledge that can be used clearly and consciously by people, and because it is a determinized and formatted thing expressed through symbols, when people use it, it is a rational and conscious use. At the same time, the transmission of episodic knowledge is non-contextual and conforms to the laws of teaching and learning in the discipline. Tacit knowledge is a highly personalized procedural knowledge that is difficult to record in writing and cannot be coded according to logical rules. It is a kind of "black box", so when people use and master it, it is often an unconscious "follow intuition" experience behavior. According to Hayek, practical knowledge is always "melted in a certain time and place", and combined with specific situations, when a specific problem or task situation, the tacit knowledge attached to the individual will naturally be awakened, and reproduced in the practical activities of human beings. Fourthly, in terms of formal characteristics, epiphenomenal knowledge is normative, systematic, stable and deterministic, objective, universal and reliable, and has been both verified by observation and rigorously argued by logic. As Kant puts it, it is something that one is subjectively sure of, but objectively certain. Tacit knowledge, on the other hand, is non-verbal, non-symbolic, subliminal logic and even unconscious, so it is fragmentary, unsystematic, difficult to standardize and difficult to master, stored in the form of experience and sensibility, and is manifested and acquired in the practical activities of individuals. Fifth, as far as the form of

expression is concerned, explicit knowledge refers to knowledge with a clear representation, such as text, symbols, formulas, graphics, principles., is solidified in written carriers, can be "transmitted to a different time, stay in a different place," the knowledge, logic, systematic, theoretical. It "emphasizes the theorizing of course content, the classroom-based learning methods, the diploma-based learning outcomes, and the organization of the school system." Tacit knowledge is knowledge preserved in the form of know-how, experience, sensation, personal skills. It is an internalized, holistic body of knowledge that cannot be taken apart, and it is projected into the situation in the form of a holistic intuitive experience that is not separated from the object and the subject and the object, and it is characterized by experience, fieldness, and gnosis. Sixth, in terms of transmission characteristics, epiphenomenal knowledge has a stable and clear connotation, which can be acquired through traditional teaching means and can be repeatedly verified, and is easy to store and transmit. Tacit knowledge, on the other hand, because it is unstable and elusive, and the principles behind it are not clear, it often manifests itself in the form of personal know-how and techniques, so it cannot be easily stored, easily transmitted, easily grasped and shared (J. Zhang, 2012). Table 2.3 shows dissimilarities concerning tacit and explicit knowledge.

Table 2.3 Differences between tacit and explicit knowledge

	Tacit Knowledge	Explicit Knowledge
Definition	Tacit knowledge: skills uttered via performance	Explicit knowledge: comprises details, concepts, and guidelines
Quality, speed, cost of the transfer	Sluggish, expensive, and indeterminate	Fast, may be costly, and precise
Diffusion	Hard to diffuse	At ease to diffuse
Residence	Experiences and memoirs	Records, brochures, databanks, policy guidebooks
Complexity	Comparative intricate	Comparatively simple
Teach-ability	Not teachable	Teachable
Observability	Not visible	Visible

Source: Adapted from Tamer et al. (2003)

2.9 Comments on current research

2.9.1 Research gap

This far-reaching review of a pertinent study on digital transformation and the performance of enterprises finds some significant gaps in the extant works. First, extant works on digital transformation and organizational performance linger in the experimental phase, yielding mixed findings. Conversely, the linkage between digital transformation and organizational performance variables (Vial, 2021) is frequently established in industrial reviews, and the

conclusions differ from the samples. More prominently, such investigations have deficiencies in the theoretical basis. Equally, most scholarships accentuate the influence of specific digital technologies on organizational performance (Berman, 2012; Dalenogare et al., 2018; Duman & Akdemir, 2021; Scott et al., 2017; K. Zhu & Kraemer, 2005). The current study contends that today's digital transformation is more about the combined influence of diverse digital innovations than about the espousal of a particular digital technology.

The first gap in the extant works concerns the inadequate study surrounding the factors that impact the relationship between digital transformation and performance more inclusively. Although, there has been a proliferation of study that has probed the relationship between digital transformation and performance (Berman, 2012; Dalenogare et al., 2018; Duman & Akdemir, 2021; Scott et al., 2017; K. Zhu & Kraemer, 2005) in different settings (as briefly discussed in Section 2.6, Chapter 2), there is an inadequate study offering holistic and systematic scrutiny and exploration of the crucial factors that facilitate the association between digital transformation and performance.

However, despite the growing interest in digital transformation as an effective approach to organizational performance, growth, and productivity across the globe. The role of digital transformation in emerging economies firms' growth performance has not received adequate attention in the extant works. Thus, it is of great significance to dissect the opportunities that digital transformation offers to firms concerning growth performance in scientific and technological enterprises in China. Especially, the mediating role of cross-border search capability and the moderating role of managers' digital concern, organizational agility, and knowledge transfer dimensions (i.e., tacit knowledge transfer and explicit knowledge transfer) in the above relationship have been rare in emerging economies.

A few exceptions have only examined cross-border search capability and managers' digital concern as moderating factors in the relationship between digital transformation and firm performance. Furthermore, there are relatively few studies that have looked at the mediating role of cross-border search capability and the moderating role of managers' digital concern, organizational agility, and knowledge transfer dimensions on the model containing digital transformation and performance consequences. To the best of the researcher's knowledge, no study has examined all these factors simultaneously in the context of digital transformation and performance. Thus, the current understanding of what contributes to successful performance is still quite limited. Another important deficiency that has been identified is that despite the growing number of studies relating to digital transformation, there is limited research conducted about emerging economies. To date, few studies have explored this issue within the context of

emerging economies in general, and China in particular. Thus, this study is a response to the above deficiencies. The study, therefore, represents an early attempt to provide a holistic examination and analysis of how digital transformation successfully impacts the performance of high-tech industries operating in emerging economies. The next section discusses the synergistic effects of the variables (cross-border search capability, managers' digital concern, organizational agility, and knowledge transfer dimensions) on the relationship between digital transformation and performance.

2.9.2 Reflections on this study

Digital transformation is acknowledged as an essential antecedent to growth performance (Xie et al., 2022). Digital transformation helps organizations to ascertain their growth performance. Digital transformation creates chances for collective learning and co-existence, leading to new knowledge, innovative approaches, processes, and product development to create value for competitive advantage. However, academics postulate that enterprises can achieve growth performance from their digital transformation activities by intervening variables (Z. Ren et al., 2018; Rosenkopf & Nerkar, 2001; Ze et al., 2018). The current study contends that enterprises' ability to seek inter-intra cross-border search capability from the business environment helps them to create a competitive edge and address the market needs of customers. These activities (i.e., the link between digital transformation-cross-border search capability-firm growth performance) contribute immensely to sustainable competitive advantage. Thus, the researcher contends that enterprises' ability to apply digital technologies can aid them in obtaining external resources from the business environment to foster growth performance activities. Second, the relationship between digital transformation and cross-border search capability may be affected by the enterprise's managers' digital concerns. Past studies have proved that managers' digital concerns can empower enterprises to maintain digital information advantages, which helps in the performance results of corporate behaviors (Adner & Helfat, 2003). Thus, managers' digital concerns can work in tandem with digital transformation to promote firm growth performance. Third, the concept of knowledge transfer and cross-border search capability emphasizes how enterprises adopt a procedure to convey knowledge to other units or organizations via a transferring grid to support cross-border search capability (R. Li et al., 2019), which in turn can contribute to firm performance. Such resources are valuable, unpredictable, and rigid for competitors to imitate in the business environment and serve as an essential influencer to firm outcomes. More interestingly, enterprises aiming for greater competitive advantage can combine tacit and explicit knowledge transfer and cross-border search capability in the business

environment.

In addition, the joint effects of organizational agility and cross-border search capability emphasize how enterprises quickly sense and respond to environmental changes (Ganguly et al., 2009; Keshtegar & Seyedzadeh, 2014; Rostami & Hafizi, 2015) to handle or support cross-border search capability, which in turn can contribute to firm performance (Ganguly et al., 2009; Keshtegar & Seyedzadeh, 2014; Nafei, 2016; Rostami & Hafizi, 2015). Pertinently, enterprises can use the hyper-competition situation to absorb useful external knowledge from the inter-intra network channel to achieve better performance capability. Besides, in such a hyper-competition situation, organizational agility supports the external knowledge from the inter-intra network channel by providing a platform where new knowledge could be generated, developed, shared, integrated, and applied towards the firm growth performance.

Thus, enterprises need to establish a favorable environment for organizational agility knowledge assimilation and adoption as it aids new digital knowledge conception to achieve growth performance. Through this process, enterprises can combine both internal bits of knowledge and external knowledge (gained through the intra-inter knowledge transfer network) to create new awareness, which at times will be hard for competitors to imitate. The application of new knowledge can generate fresh products and services, leading to firms' performance to survive and flourish in the dynamic marketplace.

2.10 Summary

This chapter has been devoted to introducing a critical review of the areas related to the research. It is divided into three broad perspectives: the first one is about digital transformation concepts and dimensions, the relationship between digital transformation and performance, the research gap underlying these relationships, and the combined effects of the variables on firm growth performance have been discussed. The chapter delves into a literature review of relevant research work done by various researchers in digital transformation and organizational performance linkage fields. It also discusses the mediating mechanism of cross-border search capability in the relationship between digital transformation and performance outcomes. Furthermore, the study discusses the moderating mechanisms of managers' digital concern, knowledge transfer dimensions, and organizational agility in the digital transformation-cross-border search capability-firm growth performance relationship model. Lastly, the research model was built and demonstrated to test the interrelated impacts of these variables. The present scholarship selects digital transformation because it is supported by a range of previous research,

and because it represents a familiar practice that is represented within the environment of the Chinese high-tech sector. The succeeding chapter (Chapter III) deals with the theoretical foundation and hypotheses development.

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Chapter 3: Research Hypotheses

The chapter presents the logical framework and hypothesis development of the study. It presents the premise for the conceptualization and development of hypotheses. It entails the integration of cross-border search capability, managers' digital concern, organizational agility, and knowledge transfer types as mediating and facilitating variables. It also examines the relationship between:

(a) digital transformation and firm growth performance;

(b) the mediating role of cross-border search capability in the digital transformation-firm growth performance links;

(c) the interaction effect of managers' digital concern and digital transformation on cross-border search capability;

(d) the interactive effect of organizational agility and cross-border search capability on firm growth performance;

(e) the interactive effect of knowledge transfer types and cross-border search capability on firm growth performance.

3.1 Hypotheses proposed

A hypothesis is a statement of the proposition put forward by a researcher as a beginning for inquiry built on current hypothetical and empirical evidence but which has not yet been evidenced to be right or wrong.

According to the research framework, this thesis proposes the following hypotheses.

3.1.1 Digital transformation and firm growth performance

In today's digital age, digital transformation is an influential missile for enterprises to build and uphold a competitive edge. It has a substantial robust effect on enterprise activities in terms of scope and intensity.

Certain authors describe the concept as a way for businesses to digitalize traditional platforms. Digital transformation is a strategy used by companies to leverage digital technologies to develop a new digital business model that helps create and deliver more value

for organizations. Digital transformation aids in improving workforce productivity, corporate services, and asset efficacy in an organization. Besides, digital transformation can abridge transaction costs and boost the supply chain. Indeed, the concept can considerably influence corporate activities and specific business operations (e.g., services) and extensively alter the organizational business model, configuration, operational routines, and processes. Thus, it is capitalizing on digital technologies and competencies to synthesize a groundbreaking business model, transfigure enterprises' activities, and prevail over rivalry (Xie et al., 2022).

In recent years, businesses have been providing highly tailored products and services to their clients. This enhances client satisfaction through the adoption of digital strategies and knowledge. The comprehensive application of digital transformation techniques condenses the cost essential for vending products and services (Zhai et al., 2022). Enterprises engaging in digital technology-entrenched business routes attain enhanced performance benefits. Contributing to these views, the current study argues that a growth performance strategy hinges on digital transformation processes in an organization to support enterprises in realizing their aims and objectives. As regards the relationship between digital transformation and performance, extant works affirm that digital transformation is a key element behind performance (Björkdahl, 2020; L. Guo & Xu, 2021; Zhai et al., 2022; Ziyadin et al., 2019).

Zhai et al. (2022) investigated the relationship between digital transformation and performance using a sample of Chinese firms. The investigation concluded that digital transformation affects a firm’s performance. The authors affirm that digital transformation has lesser cost, superior operating efficacy, and grander innovation triumphs, leading to higher performance. Björkdahl (2020) asserts that an enterprise’s digital transformation emphasizes enhancing the operative procedures in focal corporate activities. Thus, digital transformation enhances corporate processes by plummeting transaction costs, upsurging employee productivity and asset effectiveness, and boosting the supply chain.

Authors like Libert et al. (2016) and Ziyadin et al. (2019) have established a positive relationship between digital transformation and firm performance. Xie et al. (2022) research on Chinese agriculture enterprises has proved a positive linkage between digital transformation and pro-land behavior. L. Guo and Xu's (2021) studies in the Chinese manufacturing sector revealed a robust relationship between digital transformation and process-based operating performance. The authors concluded that a U-shaped relationship exists between digital transformation and profit-oriented financial performance.

From the RBV perspective, digital transformation eliminates spatial and temporal barriers, enabling businesses to benefit from existing resources (Martínez-Caro et al., 2020). For

scientific and technological enterprises, digital transformation is beneficial for breaking through time and space barriers and acquiring key resource elements in enterprise growth. At the same time, digital transformation can help enterprises adapt to important environments, save costs, and create flexibility (Singh et al., 2021), which is conducive to enterprise growth.

Based on the ongoing discussions, the present study makes the following hypothesis:

H1. Digital transformation is positively related to firm growth performance.

3.1.2 The mediating role of cross-border search capability

The cross-border search capability is defined as a firm's ability to pursue and obtain resources from an external environment to improve organizational functioning (Rosenkopf & Nerkar, 2001; Ze et al., 2018).

Previous studies have shown that digital transformation can improve multi-task information recognition and data processing capabilities, which is beneficial for scientific and technological enterprises to enhance their cross-border search capabilities. Therefore, digital transformation can enhance the advantages of multi-task information processing and promote the cross-border search capabilities of scientific and technological enterprises.

A resource is valuable, and it may support the focal enterprise in attaining a competitive edge; acquiring resources via cross-border search is a vital approach, and as a result, the process can benefit enterprises. Indeed, no enterprise has all the possessions and capabilities it desires; as a result, the cross-border search capability is a strategic element for enterprises to obtain capabilities from the outer environment to sustain a competitive edge (Gao et al., 2021).

Enterprises adopt the cross-border search capability concept to gain access to diversified resources in pursuit of enhancement and organizational effectiveness to address market demands. Proponents of DCV see enterprises as resource initiators and integrators. The ability of the enterprise to create worth hinges mainly on sets of tangible and intangible resources (Boadu et al., 2018). Thus, enterprises can attain more than normal performance and create value if they possess idiosyncratic and non-substitutable organizational resources for their operational activities. For instance, in a dynamic environment, enterprises with strong technical capabilities are connected with superior innovation outcomes to offer value (Tortoriello, 2015).

This study asserts that an enterprise's capacity to gather information through narrow and multi-task approaches is essential for acquiring and integrating diverse capabilities necessary for efficient operations. Therefore, enterprises aiming to attain a competitive edge must follow a logical process that enterprises call for effectively transferring resources (i.e., internal and external) from one context to another. Espousing best industry practices from leaders or front-

runners is one effective approach to resource application. By identifying and utilizing the most relevant resources, we can ensure optimal results and drive our success forward.

Previous studies have established a significant effect of cross-border search capability on enterprises' performance outcomes (Rosenkopf & Nerkar, 2001). Other scholarships find a positive effect of boundary-spanning on innovation and performance (Rosenkopf & Nerkar, 2001; Ze et al., 2018). Given the importance of cross-border search capability in organizational growth, the present research aims to examine whether it can mediate the association between digital transformation and firm growth performance.

From the Chinese high-tech perspective, the researcher argues that integrating external resources acquired from manifold partners to augment internal resources is vital in creating organizational growth, competitiveness, and survival. Drawing upon the DCV, these resources can play a critical role in digital transformation processes, which, in turn, will enhance firm growth performance. Consequently, cross-border search capability will mediate digital transformation and firm growth performance. Accordingly, the study hypothesizes that:

H2. Cross-border search capability mediates the positive relationship between digital transformation and firm growth performance.

3.1.3 The moderating role of managers' digital concern

Managers' digital concern denotes the managers' commitment level and mental models for the organization's digital matters. The concept is an important factor influencing enterprise operational activities for growth and competitive edge (Adner & Helfat, 2003).

Extant literature has given various accounts of the duties and responsibilities of top executives in shaping organizational activities toward growth, competitiveness, and sustainability. Indeed, top executives perform an essential role in bringing groundbreaking technology to enterprises (Rao & Weintraub, 2013). They always carry out the most important function in approving and diffusion any novel technology in the enterprise's operational activities.

Thus, top executives with high skills in digital issues can play a significant role in enterprises' development in today's market environment, which is full of uncertainty and volatility due to technological, economic, environmental, and competitive factors (Boadu et al., 2018). Such managers spend quality time on digital matters, propose the effective implementation of novel technology, and clear the necessity for innovation to put their enterprises ahead of the competition in the competitive arena.

Haugh and Robson (2005) assert that enterprises with high managers' commitment to the

direction of the technology approval process are likely to apply the know-how more speedily. However, these commitment levels exhibited by managers can be high or low. First, at a high level, managers show serious concern for all digital matters confronting the enterprise. Second, at the low level, managers show no motivation to execute or bring in technology to address digital matters in the enterprise.

Given the importance of managers' digital concerns in organizational growth, competitiveness, and sustainability, the present research examines whether managers' digital concerns can moderate the association between digital transformation and cross-border search capability.

From the Chinese high-tech perspective, the current study argues that high-level managers' digital concerns can work in tandem with digital transformation to promote cross-border search capability, which, in turn, can foster firm growth performance. Thus, managers' support stimulates know-how to aid digital transformation activities in enhancing cross-border search capability toward firm growth performance for a longer period.

Drawing upon the RBV, managers with skills in digital issues could identify and implement solutions that improve digital performance and digital competence towards cross-border search capability and uphold the enterprise ahead of the innovation and growth curve. In recent times, enterprise managers have been making smarter conclusions. As product life cycles plummet with growing technology, as a result, enterprise managers need to be more conscious of sensing the market in a digital model rather than traditional mode.

Thus, digital savvy managers can support digital transformation strategies to enhance cross-border search capability to record enterprises' long-term digital triumph. As a result, managers' digital concerns will moderate digital transformation and cross-border search capability.

Given that, the study hypothesizes that:

H3. Managers' digital concern moderates the relationship between digital transformation and cross-border search capability, such that the relationship is stronger when managers' digital concern is higher rather than lower.

3.1.4 The moderating role of knowledge transfer types

Based on the RBV perspective, knowledge is a vital strategic resource for organizational development. It is one of the foremost resources in today's turbulent market environment.

However, drawing upon the extant literature, the concept is hard to define as it is complex with a multifaceted gist (Nonaka, 1994). If knowledge is laid out in a linear model, it encompasses tacit and explicit elements. The former has dynamic characteristics, context-

specific, and set off at an individual level, while the latter stresses things that can be written and documented in words and numbers.

These knowledge dimensions are valuable factors that can aid in bringing the enterprise to a better position in the competitive arena. For enterprises to have an incessant sustainable competitive edge, knowledge transfer, which is referred to as a movement of knowledge or accrued know-how from one unit to another within or between enterprises, is one of the resources that can aid enterprises in achieving success in the business environment. Through knowledge transfer processes, enterprises gain access to knowledge and filter, assimilate, and engross it to enhance their knowledge stock. Indeed, knowledge transfer dimensions (i.e., tacit and explicit) can serve as an essential missile to technological enterprises in today's competitive environment by presenting varied knowledge and expertise to transmogrify their operating activities (Xie et al., 2022). They are an essential route for enterprise output. Knowledge transfer types can grasp enterprise knowledge buildup.

The existing scholarship establishes that the interaction between different types of knowledge transfer significantly enhances the relationship between cross-border search capability and firm growth performance. This positive impact is driven by tacit and explicit knowledge transfer. Numerous studies demonstrate a strong correlation between the individual effects of these knowledge transfer types and cross-border search capability, ultimately leading to improved firm performance across various sectors.

For example, scholars have applied and confirmed that tacit knowledge transfer is a vital resource leading to enhanced enterprise outcomes in most organizations (Xie et al., 2022). They contend that tacit knowledge transfer offers a competitive edge to enterprises possessing critical success factors such as technical skills and expertise. On the other hand, authors have recognized explicit knowledge transfer as a contributing factor to corporate performance. However, these scholars have contended that the former (i.e., tacit knowledge), as disparate to the latter (i.e., explicit knowledge), has the prospect of creating inordinate benefits to an enterprise because it is harder to replicate.

Thus, extant scholarships have proven a significant relationship between contextual variables such as knowledge transfer dimensions and an organization's innovative performance. Besides, earlier studies have proved that boundary-spanning has demonstrated significant differential effects on innovation and performance (Rosenkopf & Nerkar, 2001; Ze et al., 2018).

From the perspective of Chinese scientific and technological enterprises, knowledge is a special resource. The current study contends that knowledge transfer types can work in tandem with cross-border search capability to promote firm growth performance, which, in turn, can

lead to a competitive edge. Thus, knowledge transfer dimensions can stimulate cross-border search capability to sustain the firm growth performance for a longer period. Drawing upon the RBV, the current scholarship proposes a two-way interactive effect (i.e., tacit and explicit knowledge transfer and cross-border search capability) into firm growth performance. Thus, tacit and explicit knowledge transfer will moderate cross-border search capability and firm growth performance.

Therefore, the study hypothesizes the following:

H4a. Tacit knowledge transfer moderates the relationship between cross-border search capability and firm growth performance, such that the relationship is stronger when tacit knowledge transfer is higher rather than lower.

H4b. Explicit knowledge transfer moderates the relationship between cross-border search capability and firm growth performance, such that the relationship is stronger when explicit knowledge transfer is higher rather than lower.

3.1.5 The moderating role of organizational agility

Organizational agility describes the ability of enterprises to sense and respond to indeterminate and erratic environmental changes quickly. Thus, the concept can aid enterprises in speedily regulating their structures and retort to marketplace vicissitudes (Harsch & Festing, 2020). It is essential for enterprises facing varying situations to use production factors to attain enterprise goals, workforces, and interested parties (Shahrabi, 2012). Organizational agility is high-order capabilities put together and paid for by low-level capabilities, which work as their building blocks (Ghasemaghaei et al., 2017).

Hence, it is a vital element of an enterprise’s ability to endure and improve in a blustery environment, and it is paid for by low-level capabilities. The concept may be predominantly beneficial in scientific and technological enterprises. Since the value chain of high-tech products is multifaceted and encompasses numerous players, the market space is indeterminate and dynamic. For example, it is problematic to linger with changing end-user preferences, from in-store to virtual grocery shopping. Besides, there are recurrent vicissitudes in market rules, business models and rivals, and double agents, which make agility extremely necessary and imperative for an enterprise's continued existence.

Organizational agility can aid scientific and technological enterprises in swiftly altering processes to bump into end-user timeliness requirements for products and malleably deal with numerous vicissitudes (Zhou et al., 2019). The concept may have two sides: market capitalizing and operational adjustment agility, respectively (Lu & Ramamurthy, 2011).

The former denotes the enterprise's ability to rapidly retort to and benefit from vicissitudes by unceasingly observing and swiftly enhancing its products to solve consumer desires. It accentuates a vigorous and growth-oriented mindset about the strategic routes, policymaking, and verdicts in indeterminate circumstances (Sambamurthy et al., 2003). At a high level, this approach can provide scientific and technological enterprises with a first-mover advantage by increasing product customization and reducing response times. It helps these enterprises strengthen their competitive strategies and enhances their chances of success in a competitive marketplace (Park et al., 2017).

The latter encompasses the ability of an enterprise's inner business procedures to bodily and speedily deal with demand vicissitudes. It pinnacles fluid conversions of groundbreaking resourcefulness in the face of alteration (Lu & Ramamurthy, 2011). Chakravarty et al. (2013) assert that the two facets can enhance enterprises' outcomes via speedily observing and retorting consumers' desires.

Given the importance of organizational agility in organizational development and survival, the present research aims to examine whether organizational agility can moderate the association between cross-border search capability and firm growth performance.

The existing literature has demonstrated the individual impact of organizational agility and cross-border search capability on firm performance across various sectors. For example, several authors (Ganguly et al., 2009; Keshtegar & Seyedzadeh, 2014; Rostami & Hafizi, 2015) have found evidence supporting the positive direct effects of organizational agility on the performance of small, large, and widely-held firms.

Keshtegar and Seyedzadeh's (2014) studies support the linkage between organizational agility and firm performance. Rostami and Hafizi (2015) found a positive correlation between organizational agility and productivity. Nafei (2016) discovered a positive association between organizational agility and organizational success. Tallon and Pinsonneault (2011) pointed out organizational agility has a robust influence on performance. Conversely, earlier studies have proved that boundary-spanning has demonstrated significant differential effects on innovation and performance (Rosenkopf & Nerkar, 2001; Ze et al., 2018).

From a resource-based perspective, cross-border search capabilities benefit resource discovery and identification, while organizational agility benefits resource allocation and utilization efficiency. The organizational agility of Chinese scientific and technological enterprises can collaborate with cross-border search capabilities to promote growth and performance, which, in turn, can bring competitive advantages. Drawing upon the RBV, the current scholarship proposes a two-way interactive effect (i.e., organizational agility and cross-

border search capability) into firm growth performance.

Thus, organizational agility will moderate cross-border search capability and firm growth performance. Therefore, the study hypothesizes the following:

H5. Organizational agility moderates the relationship between cross-border search capability and firm growth performance, such that the relationship is stronger when organizational agility is higher rather than lower.

3.2 Research framework

Based on the research background and issues mentioned earlier, digital transformation may promote the firm growth performance by influencing cross-border search. At the same time, digital attention from managers, organizational agility, and the forms of knowledge transfer in enterprises (explicit and tacit knowledge transfer) may all have moderating effects on the main effect model.

In light of this, the thesis effectively integrates these variables and establishes the research framework illustrated in Figure 3.1.

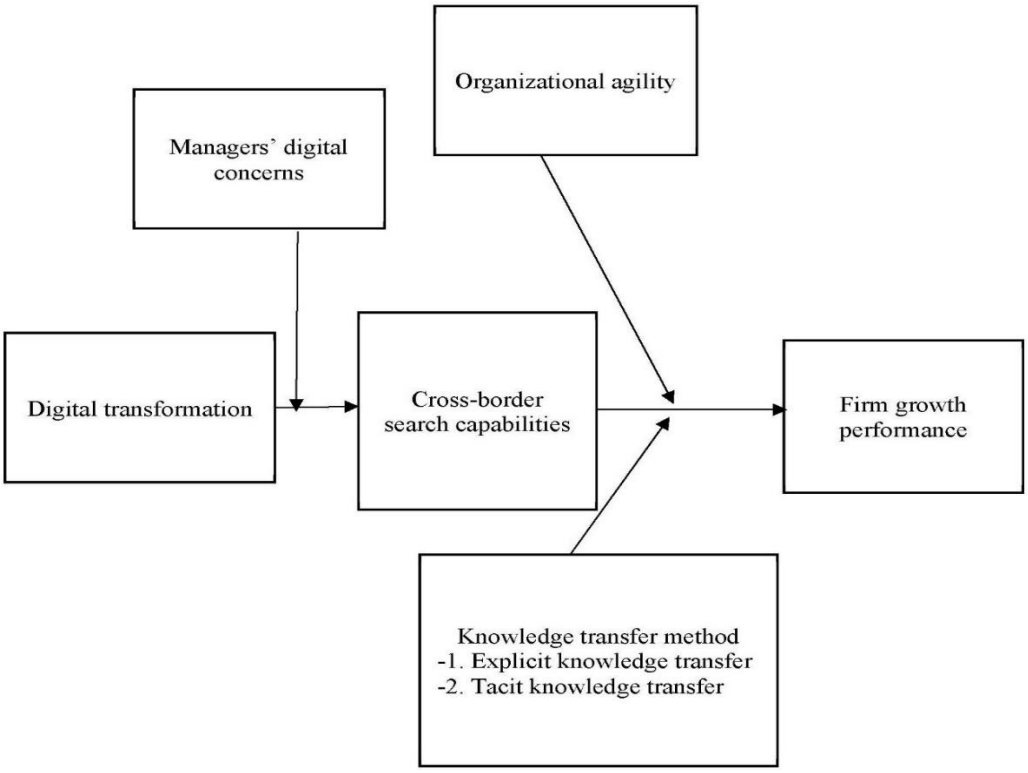

Figure 3.1 Research framework of the thesis

3.3 Research question & hypotheses summary

The previous works discussed the research background, issues, and hypotheses. Notably, each assumption serves as the answer to the research question, reflecting a one-to-one correspondence.

This thesis further summarizes these contents, the research questions and hypotheses summary as shown in Table 3.1.

Table 3.1 Research questions & hypotheses summary

Research Question (RQ)	Hypotheses
RQ-1: What is the relationship between digital transformation and firm growth performance in scientific and technological enterprises in China?	*H1. Digital transformation is positively related to firm growth performance.*
RQ-2: What is the mediation effect of cross-border search capability in the relationship between digital transformation and firm growth performance in scientific and technological enterprises in China?	*H2. Cross-border search capability mediates the positive relationship between digital transformation and firm growth performance.*
RQ-3: What is the moderation effect of managers' digital concern on the relationship between digital transformation and firm growth performance in scientific and technological enterprises in China?	*H3. Managers' digital concern moderates the relationship between digital transformation and cross-border search capability, such that the relationship is stronger when managers' digital concern is higher rather than lower.*
RQ-4: What are the moderation effects of knowledge transfer dimensions (i.e., tacit and explicit knowledge transfer) on the relationship between cross-border search capability and firm growth performance in scientific and technological enterprises in China?	*H4a. Tacit knowledge transfer moderates the relationship between cross-border search capability and firm growth performance, such that the relationship is stronger when tacit knowledge transfer is higher rather than lower.* *H4b. Explicit knowledge transfer moderates the relationship between cross-border search capability and firm growth performance, such that the relationship is stronger when explicit knowledge transfer is higher rather than lower.*
RQ-5: What is the moderation effect of organizational agility on the relationship between cross-border search capability and firm growth performance in scientific and technological enterprises in China?	*H5. Organizational agility moderates the relationship between cross-border search capability and firm growth performance, such that the relationship is stronger when organizational agility is higher rather than lower.*

Chapter 4: Methodology

The previous chapter proposed research hypotheses and discussed the possible impact relationships between independent variables, dependent variables, mediating variables, and moderating variables. This chapter will introduce the research methods, variable measurements, data, and statistical techniques used in this thesis.

4.1 Outline of Methodology

According to the research framework, this thesis examines the impact mechanism of digital transformation on firm growth performance, including direct impact, mediating effect, and moderating effect. The empirical research method based on questionnaire data is very suitable for completing these tasks, which mainly includes the following processes:

Firstly, variable definition and measurement. Based on existing literature, this study will accurately define variables such as digital transformation, cross-border search capability, managerial digital concerns, explicit knowledge transfer, implicit knowledge transfer, and organizational agility. On this basis, variable measurements were conducted based on existing research and designed as questionnaire content;

Secondly, data collection. This study will distribute survey questionnaires to target companies through alumni platforms and obtain the necessary data for the research;

Thirdly, data feature analysis. This study analyzes the demographic data of the surveyed individuals and the distribution of characteristics such as size, age, ownership, and industry of the surveyed enterprises based on the obtained data.

Finally, it's important to conduct a reliability and validity analysis. Before conducting the empirical analysis, this study will evaluate the reliability and validity of the questionnaire data. For this purpose, SPSS software will be utilized for exploratory factor analysis, while AMOS software will be employed to confirm the model's fitness.

4.2 Variables measurement

4.2.1 Independent variable

Digital transformation. Given that digital transformation is an ongoing process, this study measures the digital transformation activities of enterprises over the past three years. According to Vial (2021), Matt et al. (2015), and Hess et al. (2016), digital transformation is considered to be a transformation that takes advantage of digital technologies such as big data, cloud computing, mobile and social media platforms. Its contents mainly include using digital technology to establish new business processes, integrating digital technology to promote organizational change, attaching more importance to digital technology in enterprise operations, and supporting the dissemination of business information through digital technology. Based on these contents, this thesis forms the following four items:

(1) Our company has been driving new business processes built on technologies such as big data, analytics, cloud, mobile, and social media platforms in the last 3 years;

(2) Our company has been integrating digital technologies such as social media, big data, analytics, cloud, and mobile technologies to drive change in the last 3 years;

(3) Our company operations have been shifting toward making use of digital technologies such as big data, analytics, cloud, mobile, and social media platforms in the last 3 years;

(4) In the last 3 years, our company has been supporting the communication of commercial information through digital technologies such as big data, cloud computing, and social platforms.

4.2.2 Mediating variable

Cross-border search capabilities. Martini et al. (2017) believe that cross-border search refers to the management and sharing of internal knowledge by enterprises to search, integrate, and utilize new knowledge technologies from the external environment, such as technology trend analysis, customer trend analysis, and market research, to promote their innovation performance. Sidhu et al. (2007) described cross-border search as an activity conducted by enterprises outside their organizational boundaries, that involves acquiring new knowledge elements and discovering new opportunities. Cross-border search can be conducted in three dimensions, including supply side, demand side, and geographic space. This article refers to the above studies, this thesis designed a scale for measuring cross-border search capability. There are four items in total:

(1) Our company timely gets access to the industry technology development status and development trend;

(2) Our company understands changes in market preferences for products or services;

(3) Our company gets information about similar technology industries and companies;

(4) Our company can find partners to provide complementary products or services to the enterprise.

4.2.3 Moderating variables

Managerial Digital Concerns: This thesis draws on W. H. Song et al. (2021) and Mo et al. (2022) to measure the concern of the management environment and designs a scale of digital concerns of management, which includes four items:

(1) Our company sees digital technology innovation as an essential component of digital management;

(2) Our company regards most digital innovation as a useful strategy;

(3) Our company has a climate that is supportive of trying out new ways of using digital innovation to become an effective digital management strategy;

(4) Our company views digital innovation as unnecessary to achieve high digital performance levels.

Knowledge transfer: Leonard and Sensiper (1998), Tamer et al. (2003), Pérez-Luño et al. (2019), Gaur et al. (2019), and Zebal et al. (2019) explored the concept, characteristics, and differences between explicit knowledge and tacit knowledge. Their research shows that tacit knowledge transfer mainly refers to knowledge transfer through experience sharing, including knowledge sharing within the enterprise and knowledge exchange and learning outside the enterprise. Explicit knowledge is transmitted mainly through relatively formal documents. Based on the above literature, Boadu et al. (2021) designed the measurement items of tacit and explicit knowledge transfer variables and passed the reliability and validity test. Therefore, this study refers to the study of Boadu et al. (2021) and makes slight improvements based on the actual situation of enterprises to design the measurement scale of tacit knowledge and explicit knowledge:

Tacit knowledge transfer. Measured from the following items:

(1) We often share and communicate information about competitive behavior both internally and externally;

(2) We often share and exchange our marketing knowledge internally and externally;

(3) We often share and exchange knowledge about the culture and habits of our target market, both internally and externally;

(4) We often share and discuss know-how or related skills internally or externally.

Explicit knowledge transfer. Measured from the following items:

(1) Our company learns about new technologies through more formal documents or materials;

(2) Our company acquires new product knowledge through more formal documents or materials;

(3) Our company obtains market-related information (such as customers, suppliers, competitors, and regulators) through more formal documents or materials;

(4) Our company learns management systems and practical knowledge through more formal documents or materials.

Organizational Agility. Teece et al. (2016) pointed out that organizational agility is necessary for dynamic capability cultivation, which is conducive to enterprises' flexible response to the uncertainty of the external environment. Pavlou and El Sawy (2010), Nafei (2016), and Troise et al. (2022) defined organizational agility as developing the technical ability to respond to threats brought by competitors and technological changes flexibly, allocating resources flexibly, and responding quickly. Based on these studies, this thesis designs the measurement items related to organizational agility:

(1) Our company detects the opportunities and threats to changes in customers, competitors, and technology in time;

(2) Our company has an appropriate technology (Hardware or software), or sufficient technological ability;

(3) Our company can reconfigure its resources at the proper time;

(4) Our company analyzes important events concerning customers, competitors, and technology without any delay.

4.2.4 Dependent variable

Firm growth performance. Jacobs et al. (2011) focused on the growth performance of companies that reflect their financial condition and market outcomes in their research, including market share growth, return on sales (ROS) growth, and return on investment (ROI) growth. C. Y. Lee (2018) believes that the growth rate of enterprises involves three key variables, the current knowledge stock, the enterprise's technological learning ability (i.e. the ability to improve technological capabilities), and the knowledge obsolescence rate. With reference to

the literature of Jacobs et al. (2011) and C. Y. Lee (2018), the following measurement items were designed in this study:

(1) Compared with three years ago, our company's sales growth is significantly faster;

(2) Compared with three years ago, our company's business model has improved;

(3) Compared to three years ago, our company's products have a large number of consumers;

(4) Compared with three years ago, our company's profits have increased significantly.

4.2.5 Control variables

Based on the research of Ju et al. (2020), this thesis controls the industry, R&D investment intensity, and ownership. Referring to the research of Tang et al. (2020), firm size, age, and ownership are controlled. Among them, referring to the national economic industry classification standard of China GB/T 4754-2017 (the fourth revision in 2017, released in 2019), the industry is divided into 20 fields. On this basis, after discussing with the supervisor, the researcher decided to consolidate and count some industries based on the possible distribution of the surveyed objects and ultimately formed 15 industry classifications, namely: agriculture, forestry, animal husbandry, and fishery; mining manufacturing electricity, heat, gas, and water production and supply construction industry and real estate industry; Wholesale and retail industries, accommodation, and catering industries; Transportation, storage, and postal services information transmission, software, and information technology services finance scientific research and technology services water conservancy, environment and public facilities management residential services, repair and other service industries, leasing and business services; education culture, sports and entertainment public management, social security and social organization, health, and social work.

The R&D investment intensity is the proportion of R&D investment to sales revenue;

Measure the size of the enterprise using the number of employees;

The nature of ownership includes state-owned enterprises, domestic private enterprises, mixed ownership enterprises, foreign-funded enterprises, and Sino-foreign joint ventures. There are 5 types of ownership, represented as 1 to 5. In statistics, values from 1 to 5 only indicate the type of ownership, and the magnitude of the values has no statistical significance. To address this issue, this study further divides ownership into state-owned enterprises (represented by 1) and non-state-owned enterprises (represented by 2-4 in the questionnaire and 0 in the empirical analysis).

4.3 Research Data

4.3.1 Study population

According to the research design, the study population in this thesis is all scientific and technological enterprises. In the official website directory of China Business Encyclopedia, scientific and technological enterprises are defined as enterprises with certain technological content or intellectual property rights in their products and strong core competitiveness. This enterprise develops new products that meet market demand and maintain sustained market growth. At the same time, this thesis takes the identification of local government scientific and technological enterprises as a relatively important reference indicator. Therefore, the study population is the firms the government selected for the Chinese scientific and technological enterprises pool.

Against the rapid economic development and increasingly fierce market competition, scientific and technological enterprises are the main force in China's current economic and technological development. According to data from the National Bureau of Statistics in 2022, there will be 2 million scientific and technological enterprises in China, of which 300000 are high-end technology enterprises (according to the Ministry of Science and Technology of China). Chinese scientific and technological enterprises have a large number, strong economic influence, and market vitality, playing a crucial role in the sustainable development of the Chinese economy.

Therefore, this thesis takes scientific and technological enterprises as the research object, which has strong practical significance.

4.3.2 Questionnaire validation and data collection

This study primarily utilizes a questionnaire method to gather research data, employing a Likert scale ranging from 1 to 7 for the variables. To ensure the accuracy and authenticity of the data, various methods were comprehensively utilized in the survey questionnaire development, including literature reviews, enterprise research, and interviews.

The main process is as follows:

Firstly, based on the literature review and analysis, this thesis has developed measurement items for various research variables derived from mature scales in authoritative literature or widely accepted concept definitions. On this basis, the researcher repeated revisions to these measurement issues under the supervisor's guidance. The revision of variable measurement

indicators began in November 2022 and ended in March 2023. After five months of continuous revision and discussion, the supervisor finally recognized it and formed the first draft of the survey questionnaire for this thesis.

Secondly, the researcher conducted interviews in enterprises. In April 2023, the researcher invited multiple corporate executives from companies of different industries and scales to read and evaluate the survey questionnaire. Based on their feedback, the researcher modified and adjusted some sentences, ambiguous questions, and questions that were not in line with the actual situation of the enterprise, forming the final draft of the survey questionnaire for this thesis.

Thirdly, pre-research. In May 2023, the final draft of the questionnaires was distributed for the first time. Twenty-seven (27) questionnaires were distributed to target company executives for the first time, and 27 were collected. The preliminary data results are highly consistent with the expectations of this thesis.

Fourthly, data collection. The target audience for data collection in this thesis is senior management personnel of scientific and technological enterprises who have mastered basic operational information of the company and have a certain level of management knowledge and understanding ability. The researcher sent invitations to target company executives through alumni platforms of multiple well-known top-tier universities (mainly including MBA, DBA, and other alumni). The study sends a survey questionnaire after receiving positive responses.

The data collection period lasts two (2) months (June-July 2023). The researcher distributed 387 survey questionnaires to the target company executives, and 306 were collected, with a recovery rate of 79.07%. Excluding a total of 30 questionnaires that did not meet the filling criteria and did not pass data quality testing (mainly including failing attention testing and being tested as a non-technical enterprise (see the questionnaire in the attached table for specific testing content)), this thesis ultimately obtained 276 valid sample data, with an effective rate of 71.32%.

4.3.3 Sample characteristics analysis

This thesis collects sample characteristic information, including the respondents' gender, age, educational background, scale, proportion of research and development investment, ownership nature, government subsidies, and industry of the respondents' companies.

Table 4.1 shows the characteristics of the respondents.

Table 4.1 Characteristics of respondents

Categories	Number	%
Gender (Respondent)		
Male	194	70.29%
Female	82	29.71%
Education background (respondent)		
Below undergraduate	8	2.90%
Undergraduate level	82	29.71%
Master	156	56.52%
Doctor	30	10.87%
Age (Respondent)		
18-30	41	14.86%
31-40	96	34.78%
41-50	94	34.06%
51- 60	41	14.86%
61 and above	4	1.45%

The study's results show 194 males, accounting for 70.29%, and 82 females, accounting for 29.71%.

The distribution of educational qualifications is mainly based on undergraduate or master's degrees, with eight (8) respondents at or below the undergraduate level, accounting for 2.90%; 82 undergraduate students, accounting for 29.71%; 156 master's degree holders, accounting for 56.52%; 30 doctoral students, accounting for 10.87%. The above characteristics are consistent with the pre-evaluation results of this study. This indicates that the participants in this study have a high level of education and the ability to complete the questionnaire content well.

The age distribution is mainly from 31 to 50, with 41 people from 18 to 30, accounting for 14.86%； 96 people from 31 to 40, accounting for 34.06%; 41 to 50 are 94 people, accounting for 34.06%; 51 to 60 are 41 people, accounting for 14.86%; 61 and above are four (4) people, accounting for 1.45%.

The distribution of sample features is consistent with the current situation in China, the characteristics of the surveyed sample are shown in Table 4.1.

Table 4.2 provides statistics on the age, scale, research and development intensity, ownership, and subsidies of sample enterprises.

Table 4.2 Age, scale, R&D, ownership, and subsidies.

Firm age			Ownership		
3-5 years	99	35.87%	State-owned enterprise	79	28.62%
6-8 years	68	24.64%	Domestic private enterprises	131	47.46%
9-15 years	58	21.01%	Mixed ownership enterprises	15	5.43%
16-20 years	36	13.04%	Foreign enterprise	29	10.51%
Over 20 years	15	5.43%	Sino-foreign joint venture	22	7.97%
Firm size (number of employees)			Government subsidies		
less than 200 people	91	32.97%	< 0.5 million	82	29.71%
200-499	62	22.46%	<1 million	63	22.83%
500-999	73	26.45%	<20 million	52	18.84%

1000-4999	22	7.97%	<20 million	49	17.75%
Over 5000 people	28	10.14%	20 million or more	30	10.87%
R&D intensity (R&D sales ratio)					
<3% (Low)	95	34.42%			
3%-10% (Moderate)	93	33.70%			
10% Above (high)	88	31.88%			

For the age distribution, the results show that most companies are less than (10) years old. Among them, there were 99 enterprises in 3-5 years, accounting for 35.87%; There were 68 enterprises in 6-8 years, accounting for 24.64%; From September to 2015, there were 58 enterprises, accounting for 21.01%; From 2016 to 2020, there were 36 enterprises, accounting for 13.04%; There are 15 enterprises with over 20 years of experience, accounting for 5.43%. When examining the distribution of enterprise employees, small and medium-sized enterprises (SMEs) with fewer than 1,000 employees constitute the majority. Specifically, there are: 91 enterprises with fewer than 200 employees, which accounts for 32.97% of the total; Sixty-two (62) enterprises with between 200 and 499 employees, making up 22.46%. Seventy-three (73) enterprises with between 500 and 999 employees, representing 26.45%; Twenty-two (22) enterprises with between 1,000 and 4,999 employees, comprising 7.97%; Twenty-eight (28) enterprises with over 5,000 employees, accounting for 10.14%. This distribution highlights the predominance of smaller enterprises in the workforce.

The proportion of R&D investment in sales is relatively evenly distributed. Among them, there are 95 enterprises with R&D accounting for less than 3% of sales revenue, accounting for 34.42%; There are 93 enterprises between 3% and 10%, accounting for 33.70%; More than 10% of enterprises have 88, accounting for 31.88%.

For ownership structure, state-owned enterprises, and domestic private enterprises are the main ones. Among them, there are 79 state-owned enterprises, accounting for 28.62%; One hundred and thirty-one (131) private enterprises in China, accounting for 47.46%, and 15 mixed-ownership enterprises, accounting for 5.43%; Twenty-nine (29) foreign-funded enterprises, accounting for 10.51%; Twenty-two (22) Sino foreign joint ventures, accounting for 7.97%. Table 4.3 shows the industry distribution of sample enterprises.

Table 4.3 Industry distribution of this study

Industry		
Agriculture, forestry, animal husbandry and fishery	16	5.80%
Mining	16	5.80%
Manufacturing	68	24.64%
Electricity, heat, gas and water production and supply	14	5.07%
Construction industry and real estate industry	7	2.54%
Wholesale and retail industry, accommodation and catering industry	0	0.00%
Transportation, storage and postal services	10	3.62%
Information transmission, software and information technology services	90	32.61%

Finance	10	3.62%
Scientific research and technology services	8	2.90%
Water conservancy, environment and public facilities management	23	8.33%
Residential services, repair and other services, leasing and business services	0	0.00%
Education	6	2.17%
Culture, sports and entertainment	0	0.00%
Public management, social security and organization, health and social work	8	2.90%

The results indicate that the sample enterprises are mainly in the manufacturing, information transmission, software, and information technology service industries, with a combined proportion of 57.25%.

Specifically, there are 16 enterprises in agriculture, forestry, animal husbandry, and fisheries, accounting for 5.80%; There are 16 enterprises in the mining industry, accounting for 5.80%;

There are 68 enterprises in the manufacturing industry, accounting for 24.64%; There are 14 enterprises in the production and supply of electricity, heat, gas, and water, accounting for 5.07%; There are 7 enterprises in the construction and real estate industries, accounting for 2.54%; There are 10 enterprises in the transportation, warehousing, and postal industries, accounting for 3.62%; There are 90 enterprises in the information transmission, software, and information technology service industries, accounting for 32.61%, and 10 enterprises in the financial industry, accounting for 3.62%; There are 8 enterprises in the scientific research and technology service industry, accounting for 2.90%; There are 23 enterprises in the water conservancy, environment, and public facility management industry, accounting for 8.33%; There are 6 enterprises in education, accounting for 2.17%; There are 8 enterprises in public management, social security and social organization, health and social work, accounting for 2.90%.

4.4 Reliability and validity of constructs

4.4.1 Reliability testing of constructs

(1) This thesis uses SPSS to calculate the Cronbach’s α of each variable.

Cronbach's reliability coefficient α coefficient is a widely recognized and applied method in empirical research in management to test data reliability. It can measure the degree of internal consistency between several questions of variable in a questionnaire and, therefore, can be used to distinguish the reliability of a set of synonymous or parallel test "sums."

The results of Table 4.4 indicate that the Cronbach’s α for digital transformation is 0.928; The Cronbach’s α for cross-border search capability is 0.938; The Cronbach’s α for managers’ digital concern is 0.922; The Cronbach’s α of tacit knowledge transfer is 0.931; The Cronbach’s

α for explicit knowledge transmission is 0.947; The Cronbach's α of organizational agility is 0.939; The Cronbach's α for firm growth performance is 0.924.

Table 4.4 Cronbach's α of the constructs

Serial number	Variable Name	Item number	Cronbach's α
1	Digital transformation	Q1-Q4	0.928
2	Cross border search capability	Q5-Q8	0.938
3	Managers' digital concern	Q9-Q12	0.922
4	Tacit knowledge transfer	Q13-Q16	0.931
5	Explicit knowledge transfer	Q17-Q20	0.947
6	Organizational agility	Q21-Q24	0.939
7	Firm growth performance	Q25-Q28	0.924

According to statistical data, a Cronbach coefficient above 0.7 indicates good internal consistency. The Cronbach's α for each variable in this thesis is over 0.9, indicating it passes the reliability test.

(2) This thesis employs a small SPSS plugin to calculate the variables' composite reliability (CR).

Composite Reliability (CR) test. Composite reliability is an important indicator commonly used in empirical research to test whether data can achieve reliable combinations. The larger the CR value, the higher the consistency of internal composition. It is generally believed that when CR is greater than 0.7, the composite reliability between variables reaches a good level.

Table 4.5 shows the composite reliability of the data in this study. The results show that the composite reliability value of digital transformation is 0.9486; The composite reliability value of cross-border search capability is 0.9559，greater than 0.7; The composite reliability value of managers' digital concerns is 0.9452，greater than 0.7; The composite reliability value of tacit knowledge transfer is 0.9505，greater than 0.7; The composite reliability value of explicit knowledge transfer is 0.9618，greater than 0.7; The composite reliability value of organizational agility is 0.9563，greater than 0.7; The composite reliability value of firm growth performance is 0.9465，greater than 0.7.

The composite reliability values for the variables are all greater than 0.7. Thus, the data in this study exhibit good composite reliability (See Table 4.5. for detailed information).

Table 4.5 Composite reliability and discriminant validity tests

NO.	Variables	items	Factor load	CR	AVE
1	Digital transformation	Item1	0.903	0.9486	0.8218
		Item2	0.908		
		Item3	0.896		
		Item4	0.919		
2	Cross border search capability	Item1	0.918	0.9559	0.8444
		Item2	0.904		

3	Managers' digital concerns	Item3	0.946	0.9452	0.8117
		Item4	0.907		
		Item1	0.899		
		Item2	0.932		
		Item3	0.89		
		Item4	0.882		
4	Tacit knowledge transfer	Item1	0.948	0.9505	0.8227
		Item2	0.897		
		Item3	0.891		
		Item4	0.902		
5	Explicit knowledge transfer	Item1	0.913	0.9618	0.8628
		Item2	0.915		
		Item3	0.95		
		Item4	0.937		
6	Organizational agility	Item1	0.936	0.9563	0.8456
		Item2	0.906		
		Item3	0.91		
		Item4	0.926		
7	Firm growth performance	Item1	0.888	0.9465	0.856
		Item2	0.909		
		Item3	0.896		
		Item4	0.919		

4.4.2 Validity testing of constructs

(1) This thesis employs a small SPSS plugin to calculate the average variance extracted (AVE) of the variables, assessing the discriminant validity of the constructs

The average variance extracted (AVE), also known as mean-variance sampling, is a method of determining the discriminant validity of an array by calculating the correlation between different constructs. According to statistical data, when AVE is greater than 0.5, the discriminant validity of the array is good.

Table 4.5 shows the average variance extracted from the constructs in this study. The results show that the average variance extracted value of digital transformation is 0.8218; The average variance extracted value of cross-border search capability is 0.8444; The average variance extracted value of managers' digital concerns is 0.8117; The average variance extracted value of tacit knowledge transfer is 0.8227; The average variance extracted value of explicit knowledge transfer is 0.8628; The average variance extracted value of organizational agility is 0.8456; The average variance extracted value of firm growth performance is 0.8560.

The AVE values are far greater than 0.5. Therefore, the data in this study have good discriminant validity (See Table 4.5 for further information).

(2) This thesis uses SPSS software to calculate the Kaiser-Meyer-Olkin (KMO) value of the variables to test the structure validity of the constructs.

Structural validity test. The Kaiser Meyer Olkin test statistic is a widely recognized and

applied method for testing the structure validity of the constructs in empirical studies. It is an indicator for comparing the correlation between various latent variables, with a value range of 0-1. When the KMO value is greater than 0.7, the correlation between latent variables is strong and the construct validity is good.

The results in Table 4.6 indicate that the KMO values of all variables involved in this study are greater than 0.7, indicating that the structural validity of the latent variables in this study is good.

Table 4.6 KMO of the constructs

Serial number	Variable Name	Item number	KMO
1	Digital transformation	Q1-Q4	0.861
2	Cross border search capability	Q5-Q8	0.859
3	Managers' digital concern	Q9-Q12	0.844
4	Tacit knowledge transfer	Q13-Q16	0.845
5	Explicit knowledge transfer	Q17-Q20	0.861
6	Organizational agility	Q21-Q24	0.86
7	Firm growth performance	Q25-Q28	0.859

4.4.3 Additional testing of the constructs

This thesis uses AMOS software to do confirmatory factor analysis to test the structural validity between variables. According to Kline's (2023) research, which updated multiple versions from 2011 to 2023, and their study was cited more than 98000 times, the academic community highly recognized the conclusion. TLI, CFI, RFI, NFI, GFI, and IFI should be greater than 0.9, SRMAR should be less than 0.05, RMSEA should be less than 0.08, and x^2/df should be less than 3.

Firstly, according to the thesis framework, this thesis involves seven (7) research variables, preliminarily summarized as the following confirmatory factor analysis model, as shown in Figure 4.1.

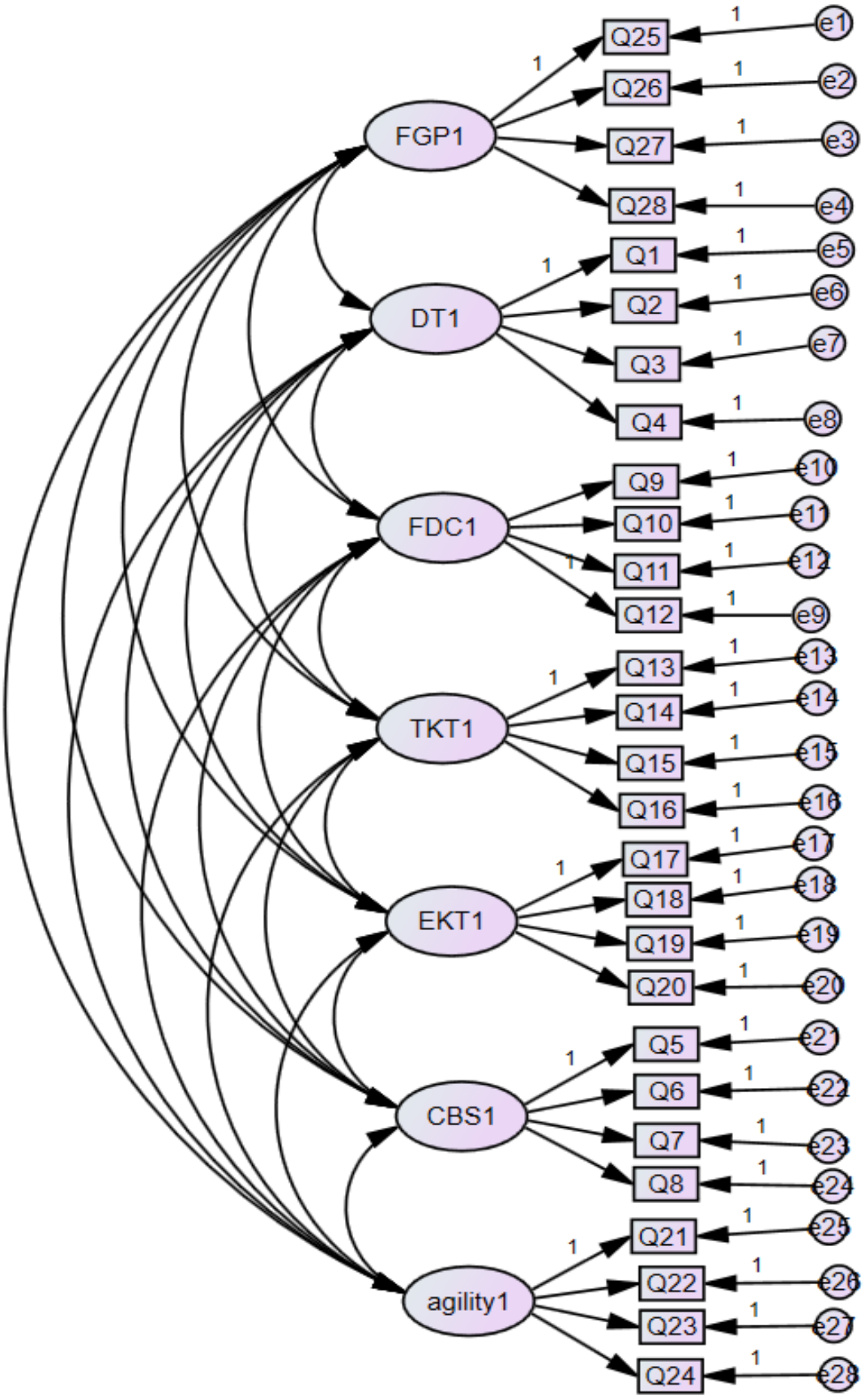

Figure 4.1 Confirmatory factor analysis models

Figure 4.1 represents the 7-factor model of this thesis.

The data were imported into Amos software to do confirmatory factor analysis, the results are shown in Table 4.7.

The CMIN/DF value is 1.081, less than 3; RMSEA is 0.017, less than 0.08; SRMR is 0.0333, less than 0.08. The NFI is 0.950, RFI is 0.942, IFI is 0.996, TLI is 0.995, CFI is 0.996, and GFI is 0.919, higher than the reference value (0.9).

In summary, the results show that all the confirmatory factor analysis results can meet the standard and requirements. It also means that the structural validity between the variables is good.

Table 4.7 Confirmatory factor analysis

Models	RMSEA	CMIN/DF	SRMAR	CFI	NFI	GFI	TLI	RFI	IFI
Standard	<0.08	<3	<0.05	>0.9	>0.9	>0.9	>0.9	>0.9	>0.9
Actual	0.017	1.081	0.0333	0.996	0.950	0.919	0.995	0.942	0.996
Result	**Good**	**Good**	**Good**	**Good**	**Good**	**Good**	**Good**	**Good**	**Good**

4.5 Common method variance test

In management, common method variance (CMV) is a systematic error that refers to the possibility of artificial covariation between variables due to the similarity of participants' characteristics in the same or similar data source environment. This impact may mislead the regression structure, affecting the accuracy of empirical research conclusions.

This thesis uses principal component analysis to test for possible common method biases. If the first factor explains a variation of less than 40%, it indicates no serious common method bias.

This thesis places all data (Including all latent variables, but excluding enterprise characteristic data and subject characteristic data) into SPSS, runs the principal component analysis, and selects "Feature value is greater than 1". The results indicate a total variation of 83.772%. The first factor explains a variation of 23.842%, thus, less than 30%. Therefore, there is no significant common method variance in this thesis.

4.6 Summary of this chapter

This chapter is methodology. Firstly, this chapter discusses the research methodology of the thesis; Secondly, the variable measurement and its theoretical basis were discussed; Thirdly, this chapter conducted reliability and validity analysis, confirmatory factor analysis, and

common method bias testing. These contents can ensure the effectiveness of the methods and data in this thesis.

Chapter 5: Empirical analysis

5.1 Descriptive statistics

5.1.1 Comparative analysis of industries

This thesis references the national economic industry classification standard GB/T 4754-2017 (fourth revision in 2017, released in 2019) and divides the industry into 20 types. Based on this, after discussing with the supervisor, the researcher decided to further consolidate and analyze some industries based on the possible distribution of the surveyed objects and ultimately formed 15 industry classifications. Each industry is represented by values ranging from 1 to 15. The detailed industry distribution of this study is shown in Table 4.3 in the previous chapter.

To address this issue, this study used a One-Way Analysis of Variance (one-way ANOVA) to compare the impact of industries on sample data. Using industry values as factors, digital transformation and firm growth performance as dependent variables. The null hypotheses are: (1) There is no significant difference in firm digital transformation in different industries; (2) There is no significant difference in firm growth performance in different industries. One-way ANOVA was conducted to obtain Table 5.1.

Table 5.1 One-way ANOVA for industries

Dependent variable	F	Significance
DT	1.149	0.324
FGP	0.667	0.770

The results showed that the impact of industry on digital transformation and firm growth performance was not significant ($p>0.05$). This means the study cannot reject the null hypothesis. It suggests that the influence of differences across industries cannot affect the data in this thesis.

5.1.2 Mean and SD of variables

To address this issue, this study used one-way ANOVA to compare the impact of industries on sample data. Using industry values as factors and digital transformation and corporate growth performance as dependent variables, one-way ANOVA was conducted to obtain Table 5.1. The results showed that the impact of industry on digital transformation and firm growth performance was not significant ($p>0.05$). This indicates that the data is not significantly

affected by industry differences.

In terms of other data, the average number of digital transformations is 4.053, with a standard deviation of 1.808, indicating that a large number of enterprises in the sample are at the forefront of digital transformation. The average cross-border search capability is 3.850, indicating that a large number of companies have weak cross-border search capabilities; The average managers' digital concern is 4.242, the average organizational agility is 4.390, the average tacit knowledge transfer is 4.199, the average explicit knowledge transfer is 4.125, and the average firm growth performance is 4.118, all of which are at a high level. See Table 5.2.

Table 5.2 Mean and SD of variables

Measurement indicators	Mean	standard deviation	N
Firm age	2.275	1.229	276
Firm size	2.399	1.294	276
Ownership	0.286	0.453	276
R&D intensity	1.975	0.815	276
Government subsidies	2.572	1.361	276
DT	4.053	1.808	276
CBS	3.850	1.907	276
MDC	4.242	1.774	276
Agility	4.390	1.837	276
TKT	4.199	1.723	276
EKT	4.125	1.889	276
Firm growth performance	4.118	1.689	276

5.2 Variable correlation analysis

Table 5.3 shows the correlation analysis of control, independent, dependent, mediating, and moderating variables.

Table 5.3 Correlation of variables

Item	1	2	3	4	5	6	7	8	9	10	11	12
Firm age	1											
Firm size	.327**	1										
Ownership	.028	.103	1									
R&D intensity	-.124*	-.032	-.138*	1								
Government subsidies	-.084	.045	-.066	.354**	1							
DT	-.173**	-.212**	-.147*	.196**	.234**	1						
CBS	-.121*	-.092	-.218**	.402**	.329**	.397**	1					
MDC	-.055	-.081	-.014	.131*	.117	.345**	.051	1				
Agility	.104	-.017	-.034	-.069	.017	.035	.053	-.109	1			
TKT	.060	-.011	-.001	.071	.070	.030	.081	.083	.158**	1		
EKT	.006	.001	-.097	.071	.108	.001	.042	-.071	.096	.049	1	
FGP	-.210**	-.220**	-.238**	.303**	.381**	.461**	.453**	.165**	.074	.112	.080	1

** Significant correlation at 0.01 level; * The correlation is significant at level 0.05.

The results show a positive correlation between the size of the enterprise and its age, with

a coefficient of 0.327 ($p<0.01$), indicating that the older the age, the larger the scale may be. The R&D intensity is positively correlated with government subsidies, with a coefficient of 0.354 ($p<0.01$), indicating that the higher the R&D intensity, the more government subsidies it receives. The digital transformation is negatively correlated with the age, scale, and ownership of enterprises, with coefficients of -0.173, -0.212, and -0.147, respectively. The correlation is significant. Cross-border search capability is positively correlated with research and development intensity, with a coefficient of 0.402, $p<0.01$; The digital focus of management is positively correlated with digital transformation, with a coefficient of 0.345, $p<0.01$; There is a positive correlation between tacit knowledge transfer and organizational agility, with a coefficient of 0.158, $p<0.01$; The firm growth performance is negatively correlated with size, age, and national ownership, and positively correlated with research and development intensity, government subsidies, digital transformation, cross-border search capabilities, and digital attention to management, which is basically in line with the expected results of the research object.

5.3 Regression analysis

5.3.1 The impact of digital transformation on firm growth performance

This thesis uses SPSS software to input questionnaire data and perform regression analysis on digital transformation and firm growth performance, resulting in Tables 5.4.

Model 1 is the regression result between the control variable and the growth performance of the enterprise. In Model 1, the adjusted R-squared value is 0.252, and the F-value is 16.446 (significance $p<0.001$). The VIF values are all less than 10, indicating that Model 1 does not have severe collinearity interference and has a good fit.

The regression results of Model 1 show that the influence of control variables such as firm age and industry on firm growth performance is not significant; The scale of a company has a negative impact on its growth performance ($\beta=-0.178$, $p<0.01$); The nature of ownership (state-owned enterprises) has a negative impact on the firm growth performance ($\beta=-0.178$, $p<0.001$); Research and development intensity has a positive impact on corporate growth performance ($\beta=0.151$, $p<0.01$); Government subsidies have a positive impact on the firm growth performance ($\beta=0.312$, $p<0.001$).

Model 2 is the regression result of the independent variable (digital transformation) on firm growth performance. In Model 2, the adjusted R-squared value is 0.339, and the F-value is

21.161 (significance p<0.001). The VIF values are all less than 10, indicating that Model 2 does not have severe collinearity interference and has a good fit.

The regression results of Model 2 show that the digital transformation of scientific and technological enterprises has a significant positive impact on their growth performance (β= 0.318, p<0.001), assuming H1 is supported. See Table 5.4 for details.

Table 5.4 Regression analysis of digital transformation and firm growth performance

Name	Firm growth performance			
	Beta (S.E.)	VIFs	Beta (S.E.)	VIFs
	Model 1		Model 2	
Control variables				
Firm age	-0.102 (0.077)	1.143	-0.076 (0.072)	1.151
Firm size	-0.178** (0.073)	1.143	-0.121* (0.07)	1.180
Ownership	-0.178*** (0.199)	1.047	-0.145** (0.188)	1.059
Industry	-0.022 (0.026)	1.045	-0.014 (0.024)	1.046
R&D intensity	0.151** (0.118)	1.185	0.120* (0.111)	1.196
Government subsidies	0.312*** (0.070)	1.180	0.252 *** (0.067)	1.222
Independent variable				
Digital transformation			0.318*** (0.049)	1.153
F value	16.446***		21.161***	
Adjusted R^2	0.252		0.339	

***p<0.001, **p<0.01, *p<0.05. sample size 276.

5.3.2 The mediating role of cross-border search capabilities

This thesis tests the mediating effect hypothesis of cross-border search capability based on the three-step method of mediating effect testing: the first step is the impact of independent variable digital transformation on the dependent variable firm growth performance; The second step is the impact of digital transformation of independent variables on the cross-border search ability of intermediary variables; The third step is the impact of cross-border search capabilities on the firm growth performance.

(1) Firstly, the impact of independent variable digital transformation on the growth performance of (dependent variable) enterprises have been tested earlier.

(2) Secondly, the impact of digital transformation of independent variables on the cross-border search capability of intermediary variables.

This thesis obtains Table 5.5 through regression analysis.

Model 3 is a regression analysis of the control variable on cross-border search capability. In Model 3, the adjusted R-squared value is 0.220, and the F-value is 13.909 (significance $p<0.001$). The VIF values are all less than 10, indicating that Model 3 does not have severe collinearity interference and is a good fit. The regression analysis results of Model 3 show that the control variables of Firm age, size, and industry have no significant impact on cross-border search capabilities; Ownership (state-owned enterprises) has a negative impact on cross-border search capabilities ($\beta=-0.161$, $p<0.01$); Research and development intensity has a positive impact on cross-border search capabilities ($\beta=0.303$, $p<0.001$); Government subsidies have a positive impact on cross-border search capabilities ($\beta=0.206$, $p<0.001$).

Model 4 is a regression analysis of the independent and control variables on cross-border search capability. In Model 4, the adjusted R-squared value is 0.288, and the F-value is 16.858 (significance $p<0.001$). The VIF values are all less than 10, indicating that Model 4 does not have severe collinearity interference and has a good fit. Model 4 regression analysis results show that digital transformation correlates with cross-border search capabilities ($\beta=0.282$, $p<0.001$). The second step of testing the mediating effect is completed. See Table 5.5 for details.

Table 5.5 Effects of digital transformation on cross-border search capabilities

Name	Cross border search capability			
	Beta (S.E.)	VIFs	Beta (S.E.)	VIFs
	Model 3		Model 4	
Control variables				
Firm age	-0.043 (0.088)	1.143	-0.019 (0.085)	1.151
Firm size	-0.060 (0.084)	1.143	-0.010 (0.082)	1.180
Ownership	-0.161** (0.23)	1.047	-0.132* (0.221)	1.059
Industry	-0.045 (0.03)	1.045	-0.038 (0.028)	1.046
R&D intensity	0.303*** (0.136)	1.185	0.275*** (0.13)	1.196
Government subsidies	0.206*** (0.081)	1.180	0.152** (0.079)	1.222
Independent variable				
Digital transformation			0.282 (0.058)***	
F value	13.909***		16.858***	
Adjusted R^2	0.220		0.288	

***p<0.001，**p<0.01，*p<0.05. sample size 276.

(3) Finally, the impact of the intermediary variable (cross-border search capability) on the dependent variable (corporate growth performance).

This thesis obtains Table 5.6 through regression analysis.

Model 5 is a regression analysis of the control variable on corporate growth performance,

and the results of this part are completely consistent with the description in Model 1.

Model 6 is a regression analysis of the relationship between the intermediary variable cross-border search capability and the control variable on the firm growth performance. In Model 6, the adjusted R-squared value is 0.315, and the F-value is 19.045 (significance $p<0.001$). The VIF values are all less than 10, indicating that Model 6 does not have severe collinearity interference and is a good fit. Model 6 regression analysis results show cross-border search capabilities correlate with corporate growth performance ($\beta= 0.289$, $p<0.001$). The third step of testing the mediating effect is completed. See Table 5.6 for details.

Table 5.6 Effects of cross border search capability on firm growth performance

Name	Firm growth performance			
	Beta (S.E.)	VIFs	Beta (S.E.)	VIFs
	Model 5		Model 6	
Control variables				
Firm age	-0.102 (0.077)	1.143	-0.090 (0.073)	1.146
Firm size	-0.178** (0.073)	1.143	-0.160** (0.070)	1.148
Ownership	-0.178*** (0.199)	1.047	-0.131* (0.194)	1.081
Industry	-0.022 (0.026)	1.045	-0.009 (0.025)	1.048
R&D intensity	0.151** (0.118)	1.185	0.064 (0.118)	1.305
Government subsidies	0.312*** (0.070)	1.180	0.253*** (0.069)	1.235
Mediating variable				
Cross border search capability			0.289 (0.051) ***	1.310
F value	16.446***		19.045***	
Adjusted R^2	0.252		0.315	

***p<0.001, **p<0.01, *p<0.05. sample size 276.

Considering Model 1- Model 6 comprehensively:

(1) Digital transformation has a significant positive impact on corporate growth performance;

(2) Digital transformation has a significant positive impact on cross-border search capabilities;

(3) Cross-border search capability has a significant positive impact on firm growth performance.

According to the definition of the mediation effect, it can be inferred that cross-border search capabilities play a partial mediating role between digital transformation and corporate growth performance.

To better test the robustness of the mediation effect of cross-border search capabilities, this

thesis runs the PROCESS software (it is embedded into SPSS), selects Model 4 in the software (here is the model number in the software, not Model 4 in this thesis), and conducts a bootstrap analysis, see Table 5.7.

Table 5.7 Bootstrap mediation effect test

	Coefficient	S.E.	Lower boundary	Upper boundary
Direct effect	0.2426	0.0505	0.1433	0.3419
Indirect effect	0.0542	0.0193	0.0231	0.1002

The 5000 results of Bootstrap show that in the digital transformation, cross-border search capability, and firm growth performance model, the direct effect is 0.2426, standard error 0.0505, $p<0.001$, the lower boundary of Bootstrap is 0.1433, the upper boundary is 0.3419, and the 95% confidence interval does not include 0.

The indirect effect is 0.0542, standard error 0.0193, $p<0.001$, Bootstrap lower bound is 0.0231, upper bound is 0.1002, and the 95% confidence interval does not include 0.

This indicates that the mediating effect of the digital transformation, cross-border search capability, and firm growth performance model in this thesis is significant, and the results are robust. Consequently, cross-border search capabilities partially mediate the relationship between digital transformation and corporate growth performance, supporting the verification of hypothesis H2.

5.3.3 The moderating effect of managers' digital concern

This thesis calculates the interaction terms between digital transformation and managers' digital concern and conducts regression analysis between the interaction terms and cross-border search capabilities to obtain the results of the moderating effect of managers' digital concern. Before calculating the interaction terms, this thesis decentralized the digital transformation and cross-border search capabilities.

This thesis obtains Table 5.8 through regression analysis.

Model 7 is a regression analysis of the impact of digital transformation and managers' digital concerns on cross-border search capabilities. In Model 7, the adjusted R-squared value is 0.297, and the F-value is 15.534 (significance $p<0.001$). The VIF values are all less than 10, indicating that Model 7 does not have severe collinearity interference and is a good fit.

The regression analysis results of Model 7 show that the control variables of firm age, size, and industry have no significant impact on cross-border search capabilities; Ownership (state-owned enterprises) has a negative impact on cross-border search capabilities ($\beta=-0.126$, $p<0.05$); Research and development intensity has a positive impact on cross-border search capabilities ($\beta=0.282$, $p<0.001$); Government subsidies have a positive impact on cross-border

search capabilities (β=0.156, p<0.01). Independent variable (digital transformation) has a positive impact on cross-border search capabilities (β= 0.321, p<0.001); Regulating variables have a positive impact on cross-border search capabilities (β=-0.117, p<0.05).

Model 8 is a regression analysis of the impact of digital transformation, managers' digital concern, and their interaction with cross-border search capabilities. In Model 8, the adjusted R-squared value is 0.331, and the F-value is 16.108 (significance p<0.001). The VIF values are all less than 10, indicating that Model 8 does not have severe collinearity interference and is a good fit.

Model 8 regression analysis results show that interaction terms have a significant positive impact on cross-border search capabilities (β= 0.191, p<0.001). Therefore, the manager's digital concern has a significant moderating effect on digital transformation and cross-border search capabilities, assuming H3 holds. See Table 5.8 for details.

Table 5.8 The moderating effect of managers' digital concern

Name	Cross border search capability			
	Beta (S.E.)	VIFs	Beta (S.E.)	VIFs
	Model 7		Model 8	
Control variables				
Firm age	-0.017 (0.084)	1.152	-0.030 (0.082)	1.157
Firm size	-0.013 (0.081)	1.181	-0.025 (0.079)	1.185
Ownership	-0.126 (0.22) *	1.063	-0.137** (0.215)	1.066
Industry	-0.030 (0.028)	1.050	-0.027 (0.027)	1.051
R&D intensity	0.282*** (0.13)	1.200	0.259*** (0.127)	1.215
Government subsidies	0.156** (0.078)	1.223	0.168** (0.077)	1.226
Independent variable				
Digital transformation	0.321*** (0.060)	1.281	0.298*** (0.059)	1.296
Moderating variable				
Managers' digital concern	-0.117* (0.058)	1.149	-0.096 (0.057)	1.162
Interaction term				
DT * MDC			0.191*** (0.029)	1.039
F value	15.534***		16.108***	
Adjusted R^2	0.297		0.331	

***p<0.001, **p<0.01, *p<0.05. sample size 276.

Based on Model 8, this thesis draws the regulatory effect diagram (Figure 5.1). The results show that when the manager's digital concern is at a high level (as shown by the dashed line),

at the same level of digital transformation, higher cross-border search capabilities can be achieved; When the manager's digital concern is at a lower level (as shown by the solid line), the corresponding cross-border search capability under the same level of digital transformation is significantly reduced.

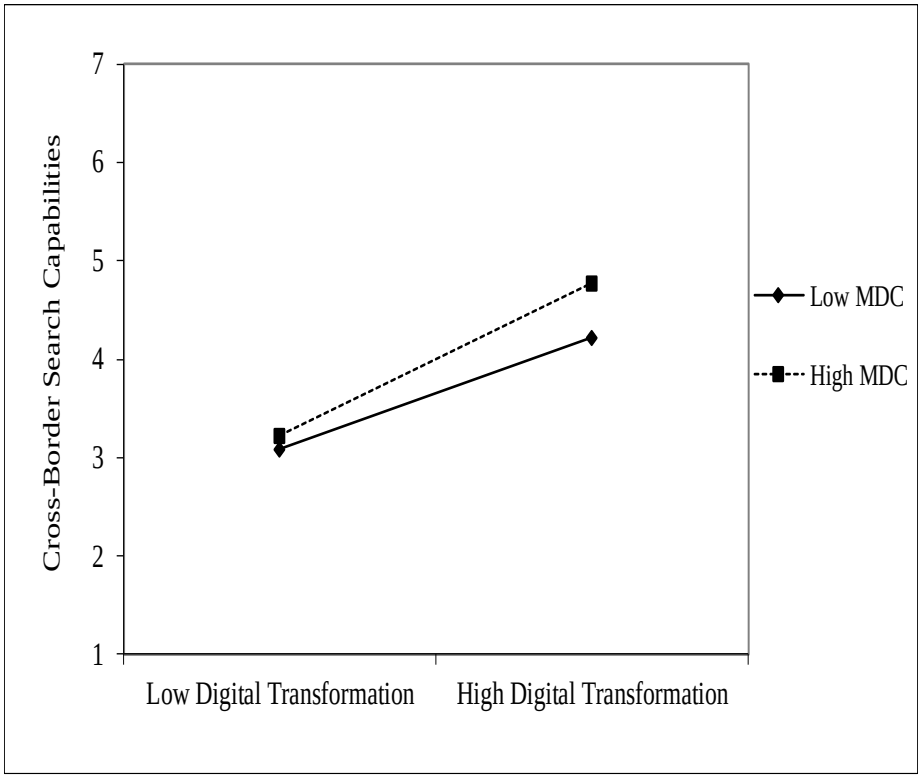

Figure 5.1 The moderating effect of managers' digital concern

This indicates that the manager's digital concern has a significant moderating effect on the model, and hypothesis 3 is further validated.

5.3.4 The moderating effect of tacit knowledge transfer

This thesis calculates the interaction term between cross-border search capability and tacit knowledge transfer. It conducts regression analysis on the interaction term and firm growth performance to obtain the results of the moderating effect of tacit knowledge transfer. Before calculating the interaction terms, this thesis conducted decentralization processing. This thesis obtains Table 5.9 through regression analysis.

Model 9 is a regression analysis of the impact of cross-border search capability and tacit knowledge transfer on the firm growth performance. In Model 9, the adjusted R-squared value is 0.317, and the F-value is 16.969 (significance $p<0.001$). The VIF values are all less than 10, indicating that Model 9 does not have severe collinearity interference and is a good fit. The regression analysis results of Model 9 show that the influence of control variables such as firm

age, industry, and R&D intensity on firm growth performance is not significant; The scale of a company has a negative impact on its growth performance (β=-0.157, p<0.01); Ownership (state-owned enterprises) has a negative impact on the firm growth performance (β=-0.133, p<0.05); Government subsidies have a positive impact on the firm growth performance (β=0.250, p<0.001). The independent variable cross-border search capability has a positive impact on the firm growth performance (β=0.285, p<0.001).

Model 10 is a regression analysis of the impact of cross-border search capability, tacit knowledge transfer, and their interaction on corporate growth performance. In Model 10, the adjusted R-squared value is 0.355, and the F-value is 17.830 (significance p<0.001). The VIF values are all less than 10, indicating that Model 10 does not have severe collinearity interference and has a good fit. Model 10 regression analysis results show that interaction terms have a significant positive impact on corporate growth performance (β=0.202, p<0.001). Therefore, the transfer of Tacit knowledge positively regulates the relationship between cross-border search capability and corporate growth performance, with a significant moderating effect. H4a is supported. See Table 5.9 for details.

Table 5.9 The moderating effect of tacit knowledge transfer

Name	Firm growth performance			
	Beta (S.E.)	VIFs	Beta (S.E.)	VIFs
	Model 9		Model 10	
Control variable				
Firm age	-0.096 (0.074)	1.153	-0.096 (0.071)	1.153
Firm size	-0.157** (0.07)	1.149	-0.136 ** (0.068)	1.161
Ownership	-0.133* (0.193)	1.081	-0.127* (0.188)	1.082
Industry	-0.009 (0.024)	1.048	-0.012 (0.024)	1.048
R&D intensity	0.061 (0.118)	1.307	0.040 (0.115)	1.318
Government subsidies	0.250*** (0.069)	1.237	0.239*** (0.067)	1.240
Independent variable				
Cross border search capability	0.285*** (0.051)	1.314	0.297*** (0.049)	1.318
Moderating variables				
Tacit knowledge transfer	0.070 (0.049)	1.017	0.050 (0.048)	1.028
Interaction				
CBS * TKT			0.202*** (0.025)	1.040
F value	16.969***		17.830***	
Adjusted R^2	0.317		0.355	

***p<0.001, **p<0.01, *p<0.05. sample size 276.

Based on Model 10, this thesis draws the regulatory effect diagrams (See Figure 5.2).

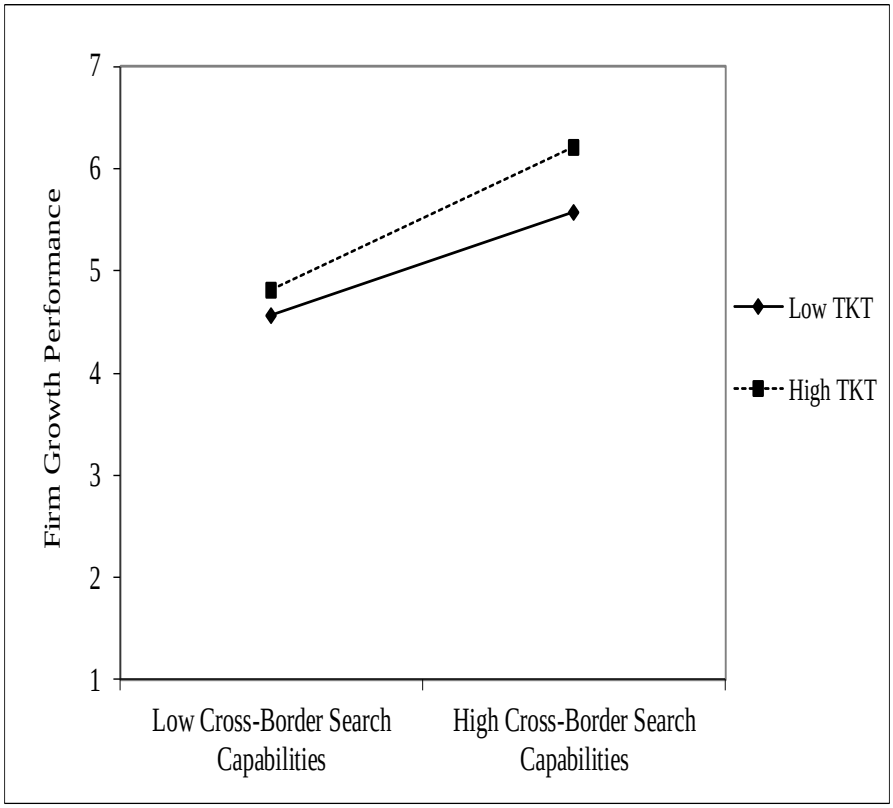

Figure 5.2 The moderating effect of tacit knowledge transfer

The results show that when the transfer of tacit knowledge is at a high level (as shown by the dashed line), under the same cross-border search capability, higher firm growth performance can be achieved; When the transfer of tacit knowledge is at a low level (as shown by the solid line), the firm growth performance corresponding to the same level of cross-border search capability significantly decreases.

This indicates that cross-border search capability has a significant moderating effect on the model and hypothesis 4a is further validated.

5.3.5 The moderating effect of explicit knowledge transmission

This thesis calculates the interaction term between cross-border search capability and explicit knowledge transfer. It conducts regression analysis on the interaction term and firm growth performance to obtain the results of the moderating effect of explicit knowledge transfer. Before calculating the interaction terms, this thesis conducted decentralization processing. This thesis obtains Table 5.10 through regression analysis.

Model 11 is a regression analysis of the impact of cross-border search capability and explicit knowledge transfer on corporate growth performance.

In Model 11, the adjusted R-squared value is 0.313, and the F-value is 16.645 (significance $p<0.001$). The VIF values are all less than 10, indicating that Model 11 does not have severe collinearity interference and is a good fit. The regression analysis results of Model 11 show that the control variables of firm age, industry, and R&D intensity have no significant impact on the firm growth performance. The scale of a company has a negative impact on its growth performance (β=-0.160, $p<0.01$); Ownership (state-owned enterprises) has a negative impact on the firm growth performance (β=- 0.129, $p<0.05$); Government subsidies have a positive impact on the firm growth performance (β= 0.251, $p<0.001$). The independent variable cross-border search capability has a positive impact on the firm growth performance (β= 0.290, $p<0.001$).

Model 12 is a regression analysis of the impact of cross-border search capability, explicit knowledge transfer, and their interaction on corporate growth performance.

In Model 12, the adjusted R-squared value is 0.345, and the F-value is 17.078 (significance $p<0.001$). The VIF values are all less than 10, indicating that Model 12 does not have severe collinearity interference and is a good fit. Model 12 regression analysis results show that interaction terms have a significant positive impact on corporate growth performance (β= 0.187, $p<0.001$).

Therefore, explicit knowledge transfer positively regulates the relationship between cross-border search capability and corporate growth performance, with a significant moderating effect. H4b is supported. See Table 5.10 for details.

Table 5.10 Moderating effects of explicit knowledge transfer

Name	Firm growth performance			
	Beta (S.E.)	VIFs	Beta (S.E.)	VIFs
	Model 11		Model 12	
Control variable				
Firm age	-0.090 (0.074)	1.146	-0.091 (0.072)	1.146
Firm size	-0.160** (0.070)	1.148	-0.148** (0.068)	1.152
Ownership	-0.129* (0.195)	1.091	-0.125 * (0.190)	1.091
Industry	-0.007 (0.025)	1.050	-0.032 (0.024)	1.068
R&D intensity	0.063 (0.118)	1.307	0.055 (0.116)	1.309
Government subsidies	0.251*** (0.069)	1.244	0.226*** (0.068)	1.263
Independent variable				
Cross border search capability	0.290*** (0.051)	1.311	0.284*** (0.050)	1.312

Name	Firm growth performance			
	Beta (S.E.)	VIFs	Beta (S.E.)	VIFs
moderating variables				
Explicit knowledge transfer	0.024 (0.045)	1.024	0.028 (0.044)	1.024
Interaction				
CBS * EKT			0.187*** (0.024)	1.050
F value	16.645***		17.078***	
R squared	0.333		0.366	
Adjusted R^2	0.313		0.345	

***p<0.001，**p<0.01，*p<0.05. sample size 276.

Based on Model 12, this thesis draws the regulatory effect diagrams (Figure 5.3). The results show that when explicit knowledge transfer is at a high level (as shown by the dashed line), under the same cross-border search capability, higher Firm growth performance can be achieved; When explicit knowledge transfer is at a low level (as shown by the solid line), the growth performance of the corresponding enterprise under the same level of cross-border search capability significantly decreases.

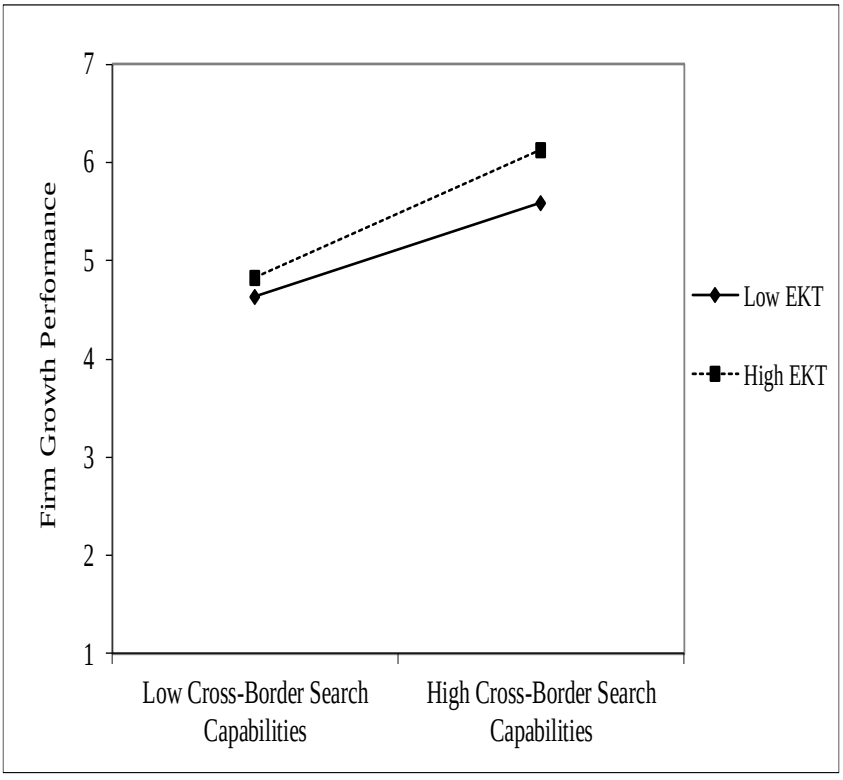

Figure 5.3 The moderating effect of explicit knowledge transfer

This indicates that cross-border search capability has a significant moderating effect in the model and hypothesis 4b is once again validated.

5.3.6 The moderating effect of organizational agility

This thesis calculates the interaction term between cross-border search capability and organizational agility. It conducts regression analysis on the interaction term and firm growth performance to obtain the results of the moderating effect of organizational agility. Before calculating the interaction terms, this thesis conducted decentralization processing.

This thesis obtains Table 5.11 through regression analysis.

Model 13 is a regression analysis of the impact of cross-border search capability and organizational agility on corporate growth performance.

In Model 13, the adjusted R-squared value is 0.316, and the F-value is 16.886 (significance $p<0.001$). The VIF values are all less than 10, indicating that Model 13 does not have severe collinearity interference and is a good fit. The regression analysis results of Model 11 show that the control variables of firm age, industry, and R&D intensity have no significant impact on the firm growth performance. The scale of a company has a negative impact on its growth performance ($\beta=-0.157$, $p<0.01$); Ownership (state-owned enterprises) has a negative impact on the firm growth performance ($\beta=-0.129$, $p<0.05$); Government subsidies have a positive impact on the firm growth performance ($\beta=0.251$, $p<0.001$). The independent variable cross-border search capability has a positive impact on the firm growth performance ($\beta=0.284$, $p<0.001$).

Model 14 is a regression analysis of the impact of cross-border search capability, organizational agility, and their interaction on corporate growth performance.

In Model 14, the adjusted R-squared value is 0.351, and the F-value is 17.518 (significance $p<0.001$). The VIF values are all less than 10, indicating that Model 14 does not have severe collinearity interference and is a good fit. Model 14 regression analysis results show that interaction terms have a significant positive impact on corporate growth performance ($\beta=0.197$, $p<0.001$). Therefore, organizational agility positively regulates the relationship between cross-border search capability and corporate growth performance, with a significant moderating effect, hypothesis H5 is valid. See Table 5.11 for details.

Table 5.11 The moderating effect of organizational agility

Name	Firm growth performance			
	Beta (S.E.)	VIFs	Beta (S.E.)	VIFs
	Model 13		Model 14	
Control variable				
Firm age	-0.097 (0.074)	1.160	-0.098 (0.072)	1.160
Firm size	-0.157** (0.070)	1.150	-0.117* (0.069)	1.195

Name	Firm growth performance			
	Beta (S.E.)	VIFs	Beta (S.E.)	VIFs
Ownership	-0.129* (0.194)	1.082	-0.122* (0.189)	1.084
Industry	-0.003 (0.025)	1.057	-0.017 (0.024)	1.062
R&D intensity	0.070 (0.118)	1.315	0.053 (0.116)	1.323
Government subsidies	0.251 *** (0.069)	1.236	0.235*** (0.067)	1.243
Independent variable				
Cross border search capability	0.284 *** (0.051)	1.317	0.287*** (0.049)	1.318
Moderating variable				
Organizational agility	0.063 (0.047)	1.037	0.047 (0.046)	1.043
Interaction				
CBS* Agility			0.197 *** (0.025)	1.077
F value	16.886***		17.518***	
Adjusted R^2	0.316		0.351	

***p<0.001, **p<0.01, *p<0.05. sample size 276.

Based on Model 14, this thesis draws the regulatory effect diagram (Figure 5.4). The results show that when organizational agility is at a high level (as shown by the dashed line), under the same cross-border search capability, higher firm growth performance can be achieved; When organizational agility is at a low level (as shown by the solid line), the firm growth performance corresponding to the same level of cross-border search capability significantly decreases. This indicates that cross-border search capability has a significant moderating effect on the model and hypothesis H5 is further supported.

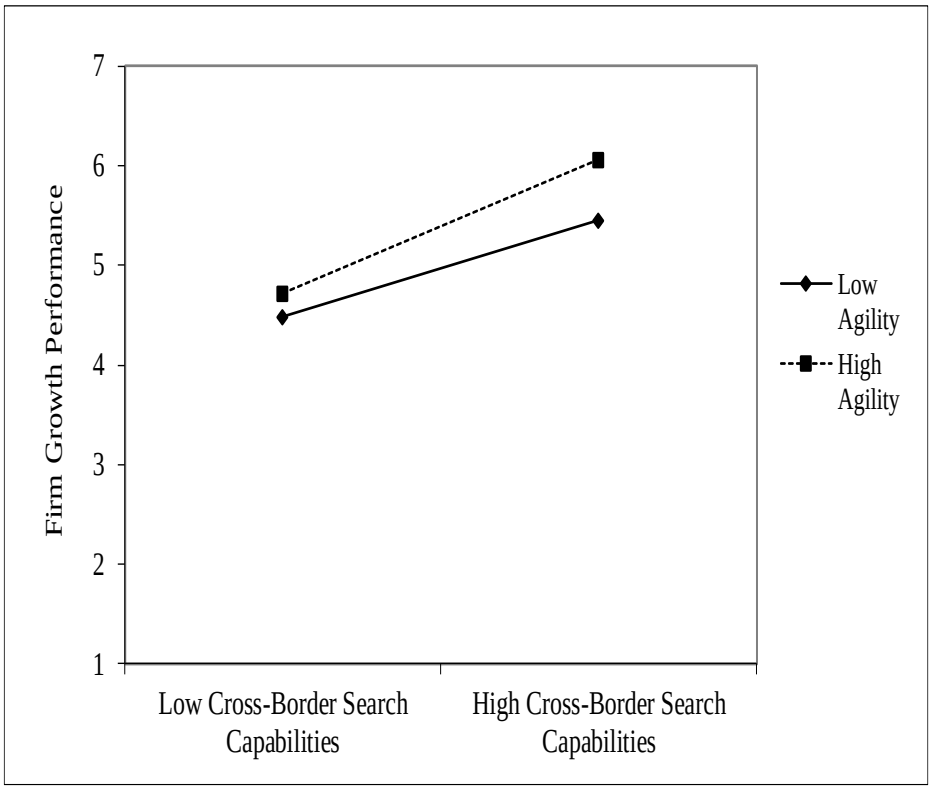

Figure 5.4 The moderating effect of organizational agility

5.4 Summary of this chapter

This chapter introduces the variable measurement, questionnaire, reliability and validity, and regression analysis of this thesis.

The results show that:

Digital transformation is positively related to firm growth performance;

Cross-border search capability mediates the positive relationship between digital transformation and firm growth performance;

Managers' digital concern moderates the relationship between digital transformation and cross-border search capability, such that the relationship is stronger when managers' digital concern is higher rather than lower;

Tacit knowledge transfer moderates the relationship between cross-border search capability and firm growth performance, such that the relationship is stronger when tacit knowledge transfer is higher rather than lower;

Explicit knowledge transfer moderates the relationship between cross-border search capability and firm growth performance, such that the relationship is stronger when explicit knowledge transfer is higher rather than lower;

Organizational agility moderates the relationship between cross-border search capability and firm growth performance, such that the relationship is stronger when organizational agility is higher rather than lower.

All the results support the research hypothesis of this thesis.

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Chapter 6: Conclusion and Discussion

This chapter summarizes the entire research process, the ultimate result, and lessons from the data analysis. The first part provides an overview and conclusive findings of the research. The second section focuses on the theoretical and practical contributions. The third part delves into the study's limitations, while the final section throws more light on suggestions for future investigation.

6.1 Research conclusion

This study posed questions, tested hypotheses, and finally answered the research question, which is shown in Table 6.1.

Table 6.1 Research questions and the results

No.	Research questions	Results
1	What is the relationship between digital transformation and firm growth performance in Chinese scientific and technological enterprises?	Digital transformation plays a positive role in firm growth performance.
2	What is the mediation effect of cross-border search capability in the relationship between digital transformation and firm growth performance in Chinese scientific and technological enterprises?	Cross-border search capabilities play a partial mediating role between digital transformation and firm growth performance.
3	What is the moderation effect of managers' digital concern on the relationship between digital transformation and firm growth performance in Chinese scientific and technological enterprises?	Manager's digital concerns appear to be a robust asset for enterprises in developing digital transformation and cross-border search capability.
4	What are the moderation effects of knowledge transfer dimensions (i.e., explicit and tacit knowledge transfer) on the relationship between cross-border search capability and firm growth performance in Chinese scientific and technological enterprises?	The tacit knowledge transfer positively regulates the relationship between cross-border search capability and corporate growth performance, with a significant moderating effect.; the explicit knowledge transfer positively regulates the relationship between cross-border search capability and corporate growth performance, with a significant moderating effect.
5	What is the moderation effect of organizational agility on the relationship between cross-border search capability and firm growth performance in Chinese scientific and technological enterprises?	When organizational agility is at a high level, under the same cross-border search capability, higher firm growth performance can be achieved; When organizational agility is at a low level, the firm growth performance corresponding to the same

	level of cross-border search capability significantly decreases.

The current study explored three central research themes. First, the study examined the direct influences of digital transformation on firm growth performance in scientific and technological enterprises in China. Second, the study examined a mediation mechanism of cross-border in the association between digital transformation and firm growth performance in scientific and technological enterprises in China. Third, the study examined the relationship between digital transformation and firm growth performance, which simultaneously integrates the moderation role of managers' digital concern, organizational agility, and knowledge transfer dimensions (i.e., explicit and tacit knowledge transfer) in scientific and technological enterprises in China by constructing a moderated mediating model.

To ascertain the exact impact of the variables, this research study extensively reviewed relevant and applicable literature, theories, and models, which informed the direction and conceptualization of the current research model. Noticeably, the study critically reviews theories such as the resource-based view (RBV) and dynamic capability view (DCV) that provide credence to the proposed logical framework. The critical review of these theories and models underlined the clarification and effect of the antecedent, namely, digital transformation, cross-border search, managers' digital concern, organizational agility, knowledge transfer dimensions (i.e., explicit and tacit knowledge transfer), and firm growth performance. The study also reviews several empirical studies on the digital transformation-performance nexus to guide the research framework and hypothesis formation.

The study engaged a quantitative technique to understand the variables and how they may implicitly influence firm growth performance. For this study, the researcher adopted a survey approach to gather data to assess all hypotheses. The survey approach is a widely preferred approach of data gathering for research purposes by many scholars due to its benefits, such as the provision of precise measurement for theoretical constructs, great statistical significance to regular and complex relationships (Gable, 1994), multiple variables, high reliability through elimination of researchers own biases and high representatives. However, this laudable approach is without limitations. Prominent among them include inflexible design, a pictorial explanation of the phenomenon at a certain time, and a low response rate. The present study intends to measure the correlation among the various constructs to establish the core statistical significance. Then, the approach seems reasonable for this kind of research.

The sample data for this thesis was sourced from scientific and technological enterprises. The data were obtained using a questionnaire issued to top executives of the scientific and

technological enterprises of China through a survey research questionnaire to ascertain the interaction among the variables in the study, using seven-point Likert scales. The seven Likert scale questionnaire items ranged from 1 Totally disagree to 7 Totally agree. The full-scale anchors were: 1. Totally disagree 2. Strongly disagree 3. Disagree 4. Neither agree 5. Agree 6. Strongly agree 7. Totally agree. The questionnaire collection mainly consisted of two stages. Stage 1 included the pre-research process (lasting for one month, i.e., May 2023), during which the researcher distributed the questionnaires to 27 executives of scientific and technological enterprises online (using email, WeChat.) for the first time, and 27 were collected. The returned questionnaires demonstrated good results, which are consistent with the expectations of the study.

Based on feedback from the pre-research, the researcher revised and clarified several difficult sentences and ambiguous questions in the questionnaire that enterprise managers did not easily understand. Stage 2 included the formal survey. The researcher randomly selected senior managers of scientific and technological enterprises who have basic operational information about the company and have a certain level of management knowledge and understanding ability from the alumni platforms of multiple well-known top-tier universities (mainly including MBA, DBA, and other alumni) and invited them to participate in the survey. Of these, 612 senior managers were willing to be surveyed. From June to July 2023 (two (2) months), 387 survey questionnaires were circulated to the target company executives, and 306 were recovered, with a recovery ratio of 79.07%. Thirty (30) questionnaires did not meet the filling criteria and, therefore, did not pass data quality testing (mainly including failing attention testing and being tested as a non-technical enterprise (see the questionnaire in the attached table for specific testing content). After eliminating any irregularly answered questionnaires, 276 usable surveys were retained, with an effective ratio of 71.32%.

The study utilized IBM SPSS and regression analysis to analyze the data. First, the researcher used the SPSS program to run all the measurement tests of the study. Thus, the study used SPSS software to test mean, standard deviation, skewness, kurtosis, exploratory factor analysis (EFA), and correlation between research variables. Furthermore, the statistical software supported the study by conducting various tests e.g., reliability and validity. Besides, this study used a regression method to determine the correlation coefficient and significance between variables. For instance, the study used the approach for considering how digital transformation can influence firm growth performance at the firm level. This technique's adoption led the researcher to avoid problems connected with aggregating scores and disaggregating observations that present adjustments in error variances. The following are the

study's main findings, which sought to answer the research objectives.

Research objective 1: To examine the impact of digital transformation on firm growth performance in scientific and technological enterprises in China.

The study predicts that digital transformation relates positively to firm growth performance. As expected, the study results indicate that digital transformation is beneficial in meeting firm growth performance. Empirical research shows that digital transformation can significantly explain the differences in growth performance among Chinese scientific and technological enterprises. These findings demonstrate that digital transformation plays a strategic role in growth performance.

Research objective 2: To assess the mediation role of cross-border search capability in the relationship between digital transformation and firm growth performance in scientific and technological enterprises in China.

The importance of cross-border search capability in this dynamic market environment cannot be over-emphasized in the paradoxical cognition surrounding digital transformation and firm growth performance in scientific and technological enterprises in China. As expected, the study finds a positive mediating effect of cross-border search capability in the relationship between digital transformation and firm growth performance. Empirically, the findings suggest that the entrance of cross-border search capabilities provides significant evidence for the change in the growth performance of Chinese science and technology enterprises. These findings demonstrate that cross-border search capabilities play a partial mediating role between digital transformation and corporate growth performance.

Research objective 3: To assess the moderation effect of managers' digital concern on the relationship between digital transformation and cross-border search capability in scientific and technological enterprises in China.

The study discovers that managers' digital concern positively influences the connection between digital transformation and cross-border search capability. Empirically, the findings suggest that the entrance of managers' digital concern provides further significant clarification power 35.3 % in the variation of cross-border search capabilities in science and scientific and technological enterprises operating in China. Thus, the findings suggest that executives with vast experience in digital matters drive the organization to apply knowledge to create new ideas, products, and services to improve digital transformation and firms' cross-border search capability. Manager's digital concerns appear to be a robust asset for enterprises in developing digital transformation and cross-border search capability.

Research objective 4: To assess the moderation effect of knowledge transfer dimensions

(i.e., explicit and tacit knowledge transfer) on the relationship between cross-border search capability and firm growth performance in scientific and technological enterprises in China.

First, the study proposes a positive effect of tacit knowledge transfer on the cross-border search capability-firm growth performance nexus. Empirically, the findings suggest that The entry of tacit knowledge transfer has provided significant support to the change in the growth performance of Chinese science and technology enterprises. Thus, the results indicate that the tacit knowledge transfer positively regulates the relationship between cross-border search capability and corporate growth performance, with a significant moderating effect. Besides, the results show that when the transfer of tacit knowledge is at a high level, under the same cross-border search capability, higher firm growth performance can be achieved; When the transfer of tacit knowledge is at a low level, the firm growth performance corresponding to the same level of cross-border search capability significantly decreases.

Second, the study proposes a positive effect of explicit knowledge transfer on the cross-border search capability-firm growth performance nexus. Empirically, the findings suggest that the entrance of explicit knowledge transfer provides further significant clarification power 36.6 % in the variation of firm growth performance in science and scientific and technological enterprises operating in China. Thus, the results indicate that explicit knowledge transfer positively regulates the relationship between cross-border search capability and corporate growth performance, with a significant moderating effect. Besides, the results show that when explicit knowledge transfer is at a high level, under the same cross-border search capabilities, higher firm growth performance can be achieved; When explicit knowledge transfer is at a low level, the growth performance of the corresponding enterprise under the same level of cross-border search capability significantly decreases.

Research objective 5: To assess the moderation effect of organizational agility on the relationship between cross-border search capability and firm growth performance in scientific and technological enterprises in China.

The study proposes a positive effect of organizational agility on the cross-border search capability-firm growth performance nexus. Empirically, the findings suggest that the entry of organizational agility provides significant evidence for the change in the growth performance of Chinese science and technology enterprises. Thus, the results indicate that organizational agility positively regulates the relationship between cross-border search capability and corporate growth performance, with a significant moderating effect. Besides, the results show that when organizational agility is at a high level, under the same cross-border search capability, higher firm growth performance can be achieved; When organizational agility is at a low level,

the firm growth performance corresponding to the same level of cross-border search capability significantly decreases.

6.2 Contributions

The current study offers potential contributions to research in digital transformation and firm growth performance. Thus, it provides a substantial contribution to both theory and practice.

6.2.1 Theoretical contribution

Firstly, the present thesis extends prior research on how enterprises utilize their digital transformation resources to create a competitive advantage. Based on the empirical findings provided in this study, digital transformation is a critical determinant of the growth performance of firms. The present research supports the views of scholars (Björkdahl, 2020; L. Guo & Xu, 2021; Zhai et al., 2022; Ziyadin et al., 2019), who attest that digital transformation is a key element behind performance. For instance, Zhai et al. (2022) using a sample of Chinese firms investigated the relationship between digital transformation and performance. The investigation concluded that digital transformation affects a firm's performance. The authors affirm that digital transformation has lesser cost, superior operating efficacy, and grander innovation triumphs, leading to higher performance. Björkdahl (2020) asserts that an enterprise's digital transformation emphasizes enhancing the operative procedures in focal corporate activities. Thus, digital transformation enhances corporate processes by plummeting transaction costs, upsurging employee productivity and asset effectiveness, and boosting the supply chain. Authors like Libert et al. (2016) and Ziyadin et al. (2019) have established a positive relationship between digital transformation and firm performance. Xie et al.'s (2022) research on Chinese agriculture enterprises has proved a positive linkage between digital transformation and pro-land behavior. L. Guo and Xu's (2021) studies in the Chinese manufacturing sector revealed a robust relationship between digital transformation and process-based operating performance. Notwithstanding, a positive effect of digital transformation in scientific and technological enterprises can be observed through spatial and temporal barrier elimination (Martínez-Caro et al., 2020). Pertinently, digital transformation can help enterprises adapt to environments, save costs, and create flexibility (Singh et al., 2021), which is conducive to enterprise growth. Hence, digital transformation can help build firms' competitive advantage and growth processes (Xie et al., 2022). The discovery complements the resource-based view (RBV) in the literature and offers sturdy pragmatic backing for the theoretical proposition that

digital transformation catalyzes performance.

Secondly, the study introduces cross-border search capability as a novel mechanism of digital transformation on firm growth performance. Dynamic capability view research suggests that the acquiring firm-specific unique technological resources from outside cohorts complements inner digital processes and operational capabilities to create value (Boadu et al., 2021) to enhance growth performance in a dynamic environment. Previous studies have shown that digital transformation can improve multi-task information recognition and data processing capabilities, which is beneficial for scientific and technological enterprises to enhance their cross-border search capabilities. From the existing literature, scholars have explored the individual effects of cross-border search capability and digital transformation on innovation and performance (Z. Ren et al., 2018). Others stress the interactive effect of cross-border search capability and digital transformation on firm sustainable growth. These studies ignore the mediating influence of cross-border search capability. It is, therefore, essential to conduct a comprehensive exploration of the internal mechanism. Based on the dynamic capability view theory, statistical results establish a significantly positive impact of cross-border search capabilities in the digital transformation-firm growth performance relationships. These findings indicate that a company's ability to acquire cross-border knowledge and technology in a dynamic environment plays an essential role in addressing market and customer needs, leading to competitive advantage. Cross-border search capabilities have become a crucial arsenal to stimulate growth and innovation agenda. Thus, the study results suggest that cross-border search capabilities play a mediating role between digital transformation and corporate growth performance. The study is a vital appendage to the dynamic capability view and extant works on firm growth performance.

Thirdly, this study provides a deeper understanding of how a manager's digital concerns can influence the digital transformation-cross-border search capabilities link. Although aspects of managers' digital concerns, digital transformation, and cross-border search capabilities have received attention separately in different models, little evidence exists showing how the interactive effect of manager's digital concerns and digital transformation influences cross-border search capabilities. The results show that interaction terms of managers' digital concern and digital transformation influence cross-border search capabilities. Therefore, the digital focus of management has a significant moderating effect on digital transformation and cross-border search capabilities. This provides an ideal supplement for the digital and growth performance literature. Therefore, the digital focus of management has a significant moderating effect on digital transformation and cross-border search capabilities.

Furthermore, the study investigates the two-way effect of organization agility and cross-border search capabilities on firm growth performance. The findings reveal the vital role of organizational agility in regulating the impacts of cross-border search capability on firm growth performance. Specifically, the interaction of high organizational agility and cross-border search capability can lead to robust growth. Thus, the researcher argues that the variable (organizational agility) can help enterprises break through the barriers to acquiring outer knowledge and technology to augment inner knowledge and technology, which, in turn, enhances firm growth performance. Thus, the study is among the first to examine the combined effects of these variables. The results from the regression analysis reveal a positive moderating effect of organizational agility on the linkage amongst cross-border search capability and firm growth performance, and the moderated mediation effect of "Digital transformation-Cross-border search capabilities-Firm growth performance" expands the application boundaries of organizational agility in the field of digital transformation and firm growth performance. The investigation demonstrates that organizational agility is crucial in value creation. It is an important determinant of organizational success that can influence firm growth performance (Ganguly et al., 2009; Keshtegar & Seyedzadeh, 2014; Rostami & Hafizi, 2015).The present research, thus, extends the application of the resource-based-view theory to digital transformation literature and shows how organizational agility sets boundary conditions of the impact of cross-border search capabilities and firm growth performance.

Moreover, this study throws more light on knowledge transfer types in organizations. Thus, it considers and substantiates another significant boundary condition: first, when tacit knowledge transfer is frequent, the role of cross-border search capabilities will become significant. From the science and technology perspective, knowledge is a vital strategic resource for organizational development. It is one of the foremost resources in today's turbulent market environment. Tacit knowledge transfer is regarded by enterprises as an important and necessary resource leading to enhanced enterprise outcomes in most organizations (Boadu et al., 2021; Xie et al., 2022). It offers a competitive edge to enterprises' critical success factors such as technical skills and expertise. Hence, tacit knowledge transfer and cross-border search capabilities can work in tandem to influence firm growth performance. From the resource-based view theory, this thesis scrutinizes the strengthening effect of tacit knowledge transfer on cross-border search capabilities and the moderation mediating effect on digital transformation-cross-border search capabilities-firm growth performance. The conclusions from regression analysis reveal that tacit knowledge transfer positively moderates cross-border search capabilities and firm growth performance. The research findings not only extend the application of tacit

knowledge transfer in the context of digital transformation but also form a useful supplement to the related research on "digital transformation effects on firm growth performance."

Equally, when explicit knowledge transfer is frequent, the role of cross-border search capabilities will become more significant. From the perspective of Chinese scientific and technological enterprises, knowledge is a special resource. Authors have recognized explicit knowledge transfer as a contributing factor to corporate performance (Boadu et al., 2021; Xie et al., 2022). Thus, explicit knowledge transfer can stimulate cross-border search capability to sustain the firm growth performance for a longer period. From the resource-based view theory, this thesis scrutinizes the strengthening effect of explicit knowledge transfer on cross-border search capabilities and the moderation mediating effect on digital transformation-cross-border search capabilities-firm growth performance. The findings from regression analysis reveal that explicit knowledge transfer positively moderates cross-border search capabilities and firm growth performance. The research findings not only extend the application of explicit knowledge transfer in the context of digital transformation but also form a useful supplement to the related research on "digital transformation effects on firm growth performance."

In conclusion, this study attempts to fill a gap in digital transformation and growth performance literature by applying a quantitative approach to examine an integrated model. Today's hyper-competitive environment pressures firms to be innovative to balance and meet multiple demands from various stakeholders. Thus, this study is highly significant. It bridges six pieces of literature on digital transformation, cross-border search capabilities, managers' digital concerns, organizational agility, knowledge transfer types, and performance to guide how firms should achieve better growth performance. Accordingly, the study contributes to resource-based views, dynamic capability views, and performance literature. Besides, the study provides practical relevance to enhance understanding of digital transformation and contextual or organizational factors. It also provides policymakers, governments, and stakeholders with specific policies, guidelines, and initiatives to support creative activities and growth.

6.2.2 Practical contribution

For practitioners and policy-makers, the research highlights new dashes of realism of digital transformation in firm growth performance within the context of emerging economies. Widespread knowledge in this era is critical for enterprises to improve their capacity to facilitate growth activities.

First, the researcher logically contends and attests that digital transformation is a power that can change growth performance. The results highlight the influence of digital transformation

on firm growth performance. The study suggests that executives must comprehend digital transformation and its antecedents as a significant arsenal influencing firm growth outcomes. Hence, they should invest adequately in digital transformation activities to enhance growth performance. Besides, executives can set up special funds for digital transformation activities, which can be tapped to implement digital projects. A higher level of investment can lead enterprises to announce more novel products or services to meet the market and environmental demands for enhanced growth performance.

Second, cutting-throat competition has forced global and domestic enterprises to seek antidotes to remain relevant in the business circle. Hence, it is prudent for enterprises to recognize the importance of cross-border search capabilities as a long way to augment inner knowledge and technology to create products or services to address market and environmental demands. The current study throws more light that cross-border search capabilities are a prerequisite for enterprises to benefit from growth performance. The results pinpointed that cross-border search capabilities play a mediating role in the digital transformation-firm growth performance nexus. The study suggests that executives should collaborate with external entities to gain access to external resources (i.e., knowledge and technology) to enhance growth performance.

Third, the findings show that a manager's digital concern positively impacts the association between digital transformation and cross-border search capabilities. Given the nature of the outcome, the study suggests that executives keep abreast of manager's digital concerns and modern ways of running organizations for competitive advantage. It is prudent for the executive to fortify inner digital technologies strategies to affect digital transformation resource application. Thus, executives must prioritize digitalization matters and their application to digital transformation activities. This can serve as a yardstick for executives to make pivotal strategies to kindle growth performance.

Fourth, enhancing firm growth performance might not be easy. For instance, such an ingenuity may demand considerable resources and backing obtainable. The study suggests that executives should understand organizational agility and cross-border search capabilities. Admittedly, the benefits ensuing from these two variables can be low or high toward firm growth performance. From the regression analysis, the conclusions show that firms' organizational agility is high, and, therefore, organizational agility positively relates to the correlation between cross-border search capabilities and firm growth performance. The study suggests that executives pay attention to organizational agility for success to prevail from organization activities to create a competitive edge. Hence, executives must have the zeal to

drive organizational agility and cross-border search capabilities to improve firm growth performance while protecting high rates of digital transformation.

Fifth, the result highlights the constructive effects of tacit and explicit knowledge transfer on cross-border search capabilities and firm growth output. These dimensions are an integral element of the RBV and an essential asset for organizational success and sustainable competitive advantage. The study suggests that executives should pay attention and offer protection for firms' knowledge resources toward sustainable competitive advantage. Firm executives should focus on sourcing new, improved knowledge and information based on their intellectual report from intra-inter network platforms to form a basis for creativity and novelty to boost innovation activities. Thus, firms' continuous collaboration and cooperation with internal and external partners for knowledge exchange is a solid direction for innovation activities.

Furthermore, the linkage amongst digital transformation, cross-border search capabilities, manager's digital concern, organizational agility, knowledge transfer types, and firm growth performance may offer a guide regarding how organizations attain superior growth outcomes utilizing digital transformation, cross-border search capabilities, manager's digital concern, organizational agility, knowledge transfer types.

More so, policymakers should create an enabling environment that will protect intellectual property, transparency, and equal access to market opportunities. Proper structures, especially a favorable institutional environment, will encourage science and technology enterprises to boost their innovation agenda. Again, policymakers should formulate policies to encourage the use of digital technology to promote science and technology enterprises protection: on the one hand, it can effectively protect science and technology enterprises' resources; conversely, digitalization can also enhance the competitive advantages of science and technology enterprises in all directions, which is conducive to the green and sustainable growth of the science and technology industry.

6.3 Limitations and direction for future research

The resulting deficiencies of the study can be resolved in future studies.

First, the present research cannot be generalized to cover overall emerging economies. Its findings emanate from a Chinese context, and the robust positive correlation among the variables may be more specific to this region. In this case, the findings and conclusions are limited to the Chinese science and technology enterprises. The study encourages future

researchers to investigate the variables (i.e., digital transformation, cross-border search capabilities, manager's digital concern, organizational agility, knowledge transfer types, and firm growth performance) in other developed and emerging economies to verify the results.

Second, the study used a self-reporting questionnaire as a data collection instrument, which relies on respondents' honesty and accuracy. Researchers can consider secondary data to validate the variables. Future researchers can also use objective measures (e.g., objective data) when dealing with firms' financial performance.

Third, this research's empirical findings stem from quantitative data, which was employed to examine the research phenomenon; future researchers can engage qualitative methods, especially a case-study approach or longitudinal research design, to shed more light on the phenomenon.

Fourth, the study used regression to empirically and simultaneously test a series of interrelated dependence correlations among the measured variables and latent constructs. Adopting such an approach in the research environment further helps the study overcome certain boundaries in traditional statistical methods through improved data access at all stages. However, the study suggests that future researchers should apply structural equation modeling to examine the variables.

Furthermore, the study introduced four contextual variables for the model. In future studies, researchers can expand the model and include equally important moderating variables. The researcher also suggests that future investigations can concentrate on other organizational factors as mediators to test the variables.

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Annex: Survey Questionnaire

Dear Sir/Madam,

Hello! Thank you for taking the valuable time to assist us in filling out this academic questionnaire. We solemnly promise to you that the information obtained in this questionnaire is only for scientific research. Please rest assured to fill it out. Sincerely thank you for your full assistance amidst your busy schedule. Thank you!

Please confirm before filling out, is your company a Chinese scientific and technological enterprises? (Possess strong technical capabilities in the field, or be selected as a scientific and technological enterprise library, or have at least one invention patent)

[ ] Yes [ ] No

Part 1: Questionnaire Information

Please check (√) the option that best suits the situation of your company.

1. Completely opposed 2. Strongly opposed 3. Oppose 4. Neutral 5. Agree 6. Strongly agree 7. Fully agree

No.	Item							
1	In the past three years, our company has been promoting new business processes based on technology, such as big data, data analysis, cloud computing, mobile communication, and social media platforms.	1	2	3	4	5	6	7
2	In the past three years, our company has been integrating digital technologies such as big data, data analysis, cloud computing, mobile communication, and social media platforms to drive organizational change.	1	2	3	4	5	6	7
3	In the past three years, our company's operations have shifted towards utilizing digital technologies such as big data, data analysis, cloud computing, mobile communication, and social media platforms.	1	2	3	4	5	6	7
4	In the past three years, our company's operations have shifted towards utilizing digital technologies such as big data, data analysis, cloud computing, mobile communication, and social media platforms	1	2	3	4	5	6	7
5	Our company promptly obtains the current status and trends of industry technology development.	1	2	3	4	5	6	7
6	Our company is able to understand changes in market preferences for products or services.	1	2	3	4	5	6	7
7	Our company obtains information on similar technology industries and companies.	1	2	3	4	5	6	7
8	Our company is able to find partners to provide complementary products or services to enterprises.	1	2	3	4	5	6	7

9	Our company believes that digital technology innovation is an important component of digital management.	1	2	3	4	5	6	7
10	Our company views most digital innovation as a useful strategy.	1	2	3	4	5	6	7
11	Our company's atmosphere is to support the attempt to use new methods of digital innovation as an effective digital management strategy.	1	2	3	4	5	6	7
12	Our company views digital innovation as a necessary component for achieving high-level digital performance.	1	2	3	4	5	6	7
13	We often share and exchange information related to competitive behavior within or outside the company.	1	2	3	4	5	6	7
14	We often share and exchange market operation related knowledge internally or externally with the company.	1	2	3	4	5	6	7
15	We often share and exchange knowledge related to the culture and habits of the target market with internal or external companies.	1	2	3	4	5	6	7
16	We often share and discuss proprietary technology or related skills internally or externally with the company.	1	2	3	4	5	6	7
17	Our company learns about new technologies through formal documents or materials.	1	2	3	4	5	6	7
18	Our company obtains new product knowledge through more formal documents or materials.	1	2	3	4	5	6	7
19	Our company obtains market related information (such as customers, suppliers, competitors, regulatory agencies) through formal documents or materials.	1	2	3	4	5	6	7
20	Our company learns management systems and practical knowledge through formal documents or materials.	1	2	3	4	5	6	7
21	Our company is able to promptly identify opportunities and threats brought about by customers, competitors, and technological changes.	1	2	3	4	5	6	7
22	Our company has appropriate software and hardware technology or sufficient technical capabilities to cope with external uncertainties.	1	2	3	4	5	6	7
23	Our company can reconfigure resources at an appropriate time.	1	2	3	4	5	6	7
24	Our company can analyze and respond to important events related to customers, competitors, and technology without delay.	1	2	3	4	5	6	7
25	Compared to three years ago, our company's sales growth has been significantly faster.	1	2	3	4	5	6	7
26	Compared to three years ago, our company's business model has undergone significant improvements.	1	2	3	4	5	6	7
27	Compared to three years ago, our company's products already have a large consumer base.	1	2	3	4	5	6	7
28	Compared to three years ago, our company's profits have increased significantly.	1	2	3	4	5	6	7

Part 2: Subject Characteristic Information

1. Your gender:

[ ] Male [ ] Female

2. Your highest education level

[ ] Below undergraduate [ ] Undergraduate

[ ] Master [ ] Doctor

3. Your age (years)

[ ] 18-30

[ ] 31-40

[ ] 41-50

[ ] 51- 60

[ ] 61 and above

Part 3: Company Background Information

1. How long has your company been established?

[ ] 3～5 year [ ] 6～8 year [ ] 9～15 year

[ ] 16～ 20 year [ ] Over 20 years

2. How many employees does your company have?

[ ] Less than 200 people

[ ] 200-499

[ ] 500-999

[ ] 1000-4999

[ ] Over 5000 people

3. Which of the following best describes the nature of your company?

[ ] State-owned enterprises

[ ] Domestic private enterprises

[ ] Mixed ownership enterprises

[ ] Foreign invested enterprise

[ ] Chinese-foreign joint venture

4. Which of the following best describes your company's industry classification? [ ]

A Agriculture, forestry, animal husbandry and fishery;

B Mining；

C Manufacturing；

D Electricity, heat, gas and water production and supply；

E Construction industry and real estate industry；

F Wholesale and retail industries, accommodation and catering industries;

G Transportation, storage and postal services；

H Information transmission, software and information technology services；

I Finance；

J Scientific research and technology services；

K Water conservancy, environment and public facilities management；

L Residential services, repair and other services, leasing and business services；

M Education；

N Culture, sports and entertainment；

O Public management, social security and organization, health and social work.

5. Please choose 2 for this question

[ ] 1

[ ] 2

[ ] 3

[ ] 4

[ ] 5

6. What is the percentage of your company's research and development expenses in sales?

[ ] <3% (low)

[ ] 3%-10% (secondary)

[ ] above 10% (high)

7. How much financial subsidies have your company received in the past year (in RMB)？

[ ] <0.5 million

[ ] <1 million

[ ] <5 million

[ ] <20 million

[ ] 20 million or above